Potential Utilisation of Industrial Waste (Red Mud) in Concrete

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ABSTRACT

In recent times metallurgical industries contribute significantly towards generation of industrial wastes and creation of substantial environmental pollution. Such a type of industrial waste is bauxite residue which contains high concentration of red mud. This paper is an overview of utilization of red mud in concrete and reduces its impact on environment. Red mud is a solid waste prepared from Bayer process during the production of alumina. The production of 1 ton alumina generates 1–2 ton of red mud. Thus, the storage of these massive amounts is economically and environmentally problematic, due to the risk of contamination of natural resources and living organisms. Based on economics as well as environmental related issues, enormous efforts have been directed worldwide towards red mud management issues i.e. of utilization, storage and disposal. Unfortunately, production of cement also involves large amount of carbon dioxide gas into the atmosphere, a major contributed for green house effect and global warming. To overcome these environmental problems there is a need of cost effective, alternatively innovative materials to be used in concrete. This study describes about such utilization and their effective usage in concrete. The red mud has being replaced on cement for various proportions such as 0, 5, 10, 15 and 20 percentage to the weight of cement. This paper points out another promising direction for proper utilization of red mud.

1. INTRODUCTION

Replacing natural raw materials in concrete with industrial wastes may offer a much sought after opportunity to mitigate today's waste management problems. Upgrading industrial wastes to alternative raw materials in concrete is both technically and economically advantageous for a wide range of applications, including the fabrication of concretes and mortars. The search for an economically and environmentally viable alternative has led to the study of red mud for various applications in construction industry. Red mud generated out of Bayer's process for alumina production from Bauxite is a high volume solid waste, doesn't have any wide industrial applications. So the red mud is used as alternative material in the construction industries. Based on present technologies, there is 0.8~1.76 tonne red mud generated by each 1t alumina produced. The worldwide alumina industry produces over 70 million dry metric tons of bauxite residue annually.

1.1 RED MUD

Red mud is the industrial waste generated during the production of alumina. Presence of Alumina and Iron oxide in red mud compensates the deficiency of the same components in limestone which is the primary raw material for Cement production. Presence of soda in the red mud which when used in Clinker production neutralizes the sulphur content in the pet coke that is used for burning clinker enroot cement production and adds to the cement's setting characteristics. Red Mud generated in the form of thick concentrated slurry in the Bayer's process was pumped to the Red Mud pond containing about 500 to 600 gpl of solids by high energy positive displacement pumps. MALCO discovered that red mud could be tried as an alternative for the Low Grade Bauxite (LGB) which the cement industries used for cement production. Over the years, many attempts have been made to find a use of red mud, but none have proven to be economically satisfactory.

RED MUD

1.2 PROPERTIES OF RED MUD

1. Particle size of dry red mud : less than 44 microns
2. Appearance and odour : Red and earthy odour with slight pungent
3. pH : 11 to 12
4. Density : 2.70 g/cm^3

1.3 CHEMICAL AND MINERALOGICAL COMPOSITION OF RED MUD

Red mud has a complex mineralization, which depends on the chemical and mineralogical composition of the processed bauxite and on the autoclaving conditions employed during the Bayer process treatment. It consists partly of minerals that do not dissolve during the caustic treatment of

the bauxite and also of components originating during leaching (DSP). Red mud residue consists of minerals like hematite α−Fe_2O_3, goethite FeO(OH), boehmite $Al_2(OOH)_2$, gibbsite $Al(OH)_3$, anatase or rutile TiO_2, quartz SiO_2, calcium carbonate and calcium aluminates from lime addition, and also of what is known as the desilication product (DSP), which contains not only silica but also considerable quantities of unrecovered alumina and soda. Desilication product plays a critical role in the Bayer plant process since it provides the mechanism for the removal of silica taken into solution during digestion by caustic soda. Chemically this is hydrated sodium aluminium silicate, approximating to the natural mineral Cancrinite.

2. EXPERIMENTAL PROGRAMME

This investigation is to study the workability, and strength properties of concrete mix with varying percentage(0,5,10,15,20) replacement of cement replacement by red mud. Totally 30 specimens were casted specimens. Out of these 6 cubes were for 0% at 7days and 28days, 6 for 5% at 7 days and 28 days, 6 were for 10% at 7 days and 28 days, 6 were for 15% at 7 days and 28days and the remaining were for 20% at 7 days and 28days. The specimens are casted in a mould of size 150 x 150 x 150 mm. Initially the mould is oiled to ease the removal of specimen from the mould. The specimens are casted in such a way that the specimens are free from air voids. The top surface of the cubes are smoothened and is kept undisturbed for 24 hours. Then the specimens are demoulded and kept under curing for 28 days. Cube are casted for compression test and cylinders are casted for tensile strength.

FIG 2.1 SPECIMENS

3. TEST AND RESULTS

The result of the test that was carried out on the M_{20} grade of concrete to evaluate their workability, and strength properties are presented in this chapter. The effects of the concrete mixtures with Red mud as a industrial waste as a replacement of cement.

3.1 CUBE COMPRESSIVE STRENGTH CONCRETE:

The average compressive strength of M_{20} grade result at the age of 7, 28 days are listed in table 4.2 and 4.3 the variations of average cube compressive strength are plotted in the form of graphs as shown in figure. From the test result it has been observed that the maximum compressive strengths are obtained for mixes with 15% replacement of cement by red mud. That is, as the red mud content in the concrete increases from zero percent the compressive strength increases when granite powder content reaches 15% and thereafter, it gradually falls off.

TABLE 3.1 AVERAGE RESULTS OF 7 DAYS OF CUBE FOR COMPRESSIVE STRENGTH

GRADE OF CONCRETE	% OF RED MUD USED	AVERAGE COMPRESSIVE STRENGTH(N/mm^2)
M20	0%	13.23
	5%	13.30
	10%	14.24
	15%	14.12
	20%	13.34

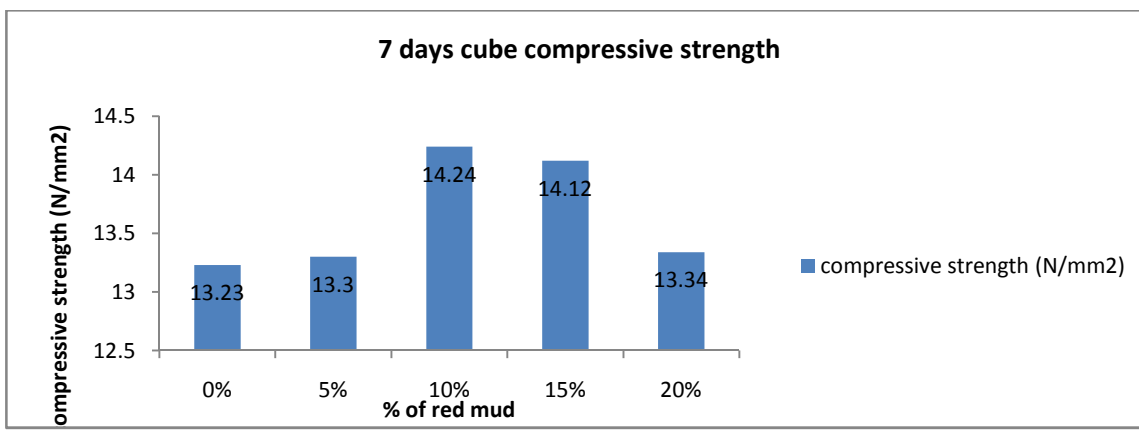

Figure 3.1 Compressive Strength of Cubes for 7 Days

Table3.2 Results Of 28 Days of Cube for Compressive Strength

GRADE OF CONCRETE	PERCENTAGE OF RED MUD	AVERAGE COMPRESSIVE STRENGTH(N/mm^2)
M20	0%	28.33
	5%	30.16
	10%	34.33
	15%	38.23
	20%	36.21

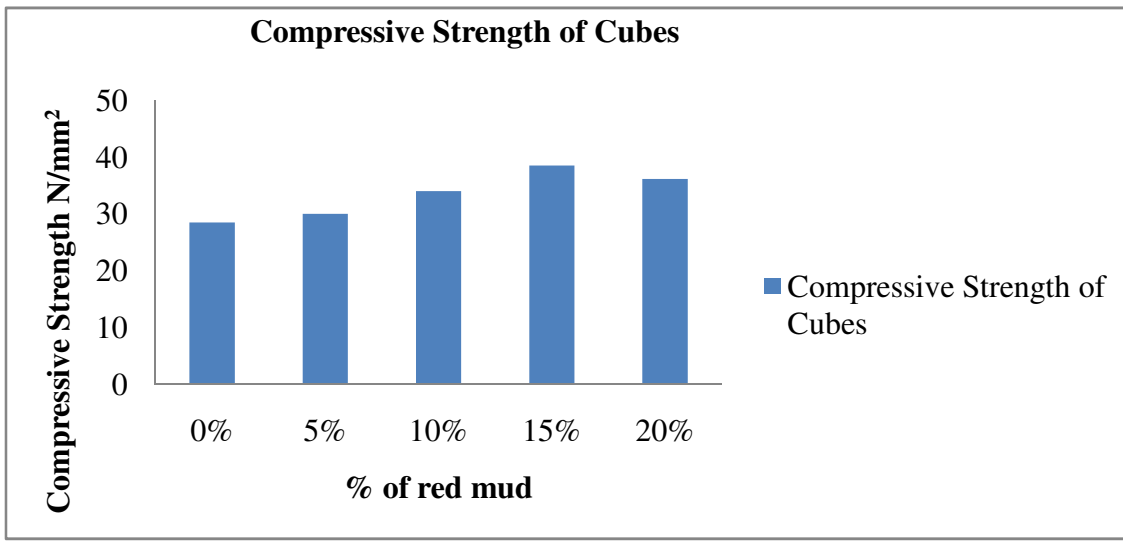

Figure 4.2 Compressive Strength of Cube for Specimen

For each percentage of replacement 3 specimens were tested and average result is shown in table and graph.

3.2 SPLIT TENSILE STRENGTH OF CONCRETE

The results of split strength tensile strength of concrete at the age of 28 days are presented in table. The variation of split tensile strength at the age of 28 days with percentage of red mud is plotted in the form of graph as shown in fig. from the results, it has been observed that the maximum split tensile strength is obtained for mixes with 15% replacement of cement by red mud. It is also observed that the split tensile strength increases with the increase in red mud content up to 15% and thereafter, it gradually degreases. It is seen that the strength of concrete in compression and the strength of concrete in split tensile are closely related and the ratio of the two strengths depends on the general level of strength of concrete.

Table 3.3 Results oOf 28 Days of Cylinders for Split Tensile Strength

GRADE OF CONCRETE	PERCENTAGE OF RED MUD	AVERAGE SPLIT TENSILE STRENGTH(N/mm^2)
M20	0%	2.89
	5%	2.97
	10%	3.01
	15%	3.14
	20%	2.87

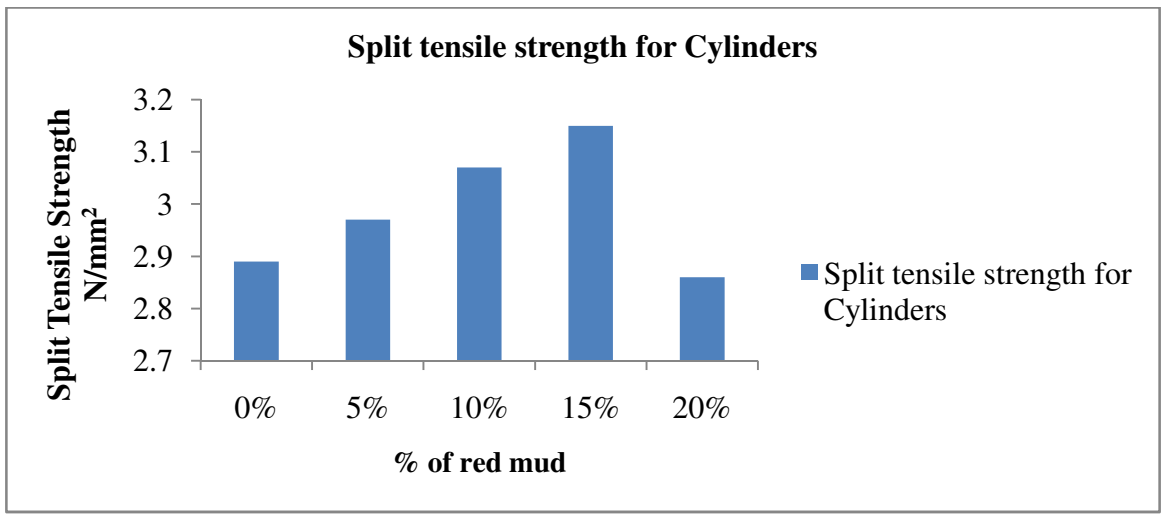

Fig 3.3 Split Tensile Strength of Cylinders for Specimen

4. CONCLUSION

In our effort to utilize red mud in concrete, we have identified the optimum percentage of red mud that can be replaced in concrete to attain the high strength. The optimum percentage of red mud is identified by the compression test and split tensile test. From the test results, it is clear that the strength of the specimens increases for the replacements 5%, 10% & 15% and then the strength of the specimens starts decreasing. Hence, the optimum percentage of cement replacement by red mud is determined to be 15% whose 7 days compressive strength is 14.12N/mm^2, 28 days compressive strength is 38.23N/mm^2 and tensile strength is 3.14N/mm^2. The choice of selecting red mud as a replacement material not only increases the strength, but also protects the environment as it is one of the source for causing environmental pollution.

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