Experimental Study on Partial Replacement of Cement by Red Mud

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Abstract **- The Bayer Process for the production of alumina from Bauxite ore is characterized by low energy efficiency and it results in the production of significant amounts of dust like, high alkalinity bauxite residues known as red mud. Disposal of large quantities of red mud; a solid-waste generated at the Aluminum plants all over the world possess an increasing problem of storage, land cost & availability and pollution. Nowadays, the wastes are not having any industrial applications, so it can be innovatively using these wastes as a raw material in the civil engineering field. Availability of raw material required for manufacturing of cement and production of concrete are limited in nature. So as to overcome this problem it is very much essential to utilize the industrial waste materials and by-products generated in manufacturing of cement and in concrete construction. By taking cementitious behaviour of the red mud into account, an experiment was carried out to partially replace the cement by red mud in concrete for different percentages (0%, 5%, 10%, 15%, 20%, 25%) and also its effects on the strength and other properties of the concrete is studied by compressive strength ,split tensile strength for M30 grade concrete.**

Key words: Bayer process, Red mud, Compressive strength test, Split tensile test.

I. INTRODUCTION

Global production of cement has more than doubled over the past 15 years due to Industrialization and urbanization . The major ill effect of these global processes is the production of large quantities of industrial wastes and the problems related with their safe management and disposal. Second problem is the scarcity of land, materials and resources for ongoing developmental activities, including infrastructure. Production of aluminium is expected to grow to over 50 million tonnes in 2015. Over 95% of the alumina manufactured globally is derived from bauxite ore by Bayer's process. Bayer's process for the production of alumina results in the production of significant amounts of dust-like, high alkaline bauxite residues known as red mud. It is one of the largest industrial by-products in modern society estimated at about 3000 million tonnes at the end of 2010 and the global inventory is growing approximately by 120 million tonnes per annum. Source of bauxite and the minerological process parameters determines the chemical and minerological composition of bauxite residue. About 1-1.6 tonnes of red mud is generated per tonne of alumina. The disposal cost of red mud is also very high (1-2% of alumina price). 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. 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 and also its effects on the strengthen other properties of the concrete.

II .LITERATURE REVIEW

1. A. B. Sawant et al studied significance of red mud over Portland cement by partial replacement of cement up to certain extent.

2. Prasad n bishetti et al studied about Red Mud is a waste generated by the aluminium industry (an average of 3million tons per year) in a Bayer's process and its 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 and also its effects on the strength and other properties of the concrete.

3. Kusum Deelwal et al studied the characteristic properties of Red Mud and possible use as a geotechnical material. Basics properties like Specific gravity, Particle size distribution, Atter Berg's limit, OMC and MDD are determined.

III. EXPERIMENTAL PROGRAMME

A.MATERIALS

Materials required for this concrete are Cement, Red mud, Fine aggregate, Coarse aggregate, Water, Super plastizicer.

1.Cement: Ordinary Portland Cement 43 Grade confirming to IS: 269-1976 was used throughout the investigation. The cement used is fresh and without any lumps. Different tests were performed on the cement to ensure that it confirms to the requirements of the IS specifications. The properties are given in table 1 & 2.

Table 1:- Chemical properties of cementitious material

COMPOSITION	CEMENT	RED MUD
Fe_2O_3	0.5-6%	20-30%
Al_2O_3	3-8%	18.9-20%
SiO_2	17-25%	8-10%
CaO	60-67%	20-22%

Table2:-Physical properties:

DESCRIPTION	CEMENT	RED MUD
Specific gravity	3.15	3.04
Standard consistency	30%	33%
Initial setting time(min)	103	300
Particle size(μm)	0.1-50	10-30
Surface area(m^2/g)	0.93	20.27

2.Coarse aggregate: Locally available coarse aggregate having the maximum size of 20 mm down size and confirming to Table 2 of IS 383 are used in the present work. The specific gravity of coarse aggregate is found to be 2.64. The water absorption test on coarse aggregate is found to be 0.4%.The properties of coarse aggregate are given in table 3.

Table3:- Properties of coarse aggregate

S.NO	DESCRIPTION	RESULT
1	Specific gravity	2.85
2	Fineness modulus	7.5
3	Water absorption	0.31%
4	Moisture content	NIL

3.Fine aggregate: The sand used for the experimental program is locally available river sand and passing through 4.75mm sieve as per IS 383 provision. The specific gravity of fine aggregate is found to be 2.62. The water absorption test on fine aggregate is found to be 1.0% .The properties of fine aggregate are given in table 4.

Table 4:- Properties of fine aggeregate

S.NO	DESCRIPTION	RESULT
1	Specific gravity	2.54
2	Fineness modulus	2.86
3	Water absorption	1.04%
4	Moisture content	2%
5	Zone	II

4.Red mud: The Red mud used for the replacement of cement is brought from Steel industry obtained by Bayer's process.The characteristics of Red mud depend on the nature of the bauxite ore used. It has been Neutralized by using commercially available HCl to bring down the ph from 10.6 to 8.6. And mud was sieved and uniform powder passing through 1.18mm was used. The specific gravity of Red mud is found to be 2.93

IV. MIX DESIGN

Grade of concrete : M30
Cement : OPC 43 grade
Target Strength : fck+1.65(s) =38.25 N/mm2
Cement content : 372 kg/m^3
Water/Cement ratio : 0.45
River sand content : 726.91 kg/m^3
Coarse aggregate content: 1145.64 kg/m^3
Chemical admixture : Conplast SP-430 (0.3% by weight of Cement)

Table5 :- Mix design ratio

Cement	Fine aggregate	Coarse aggregate	Water	Admixture
1	2.925	4.696	0.45	0.3%

V. TEST ON FRESH CONCRETE

A. SLUMP CONE

This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to the workability.The obtained results are given in the table 6

Table6:- Slump cone test

W/C ratio	Used % of red mud	Slump value
0.45	0	40
0.50	5	34
0.55	10	30
0.60	15	28
0.65	20	25
0.70	25	18

VI.TEST ON HARDENED CONCRETE

A. CASTING:

The required raw materials like cement, red mud, coarse aggregates, sand, and accelerator have to be mixed as per mix ratio. Cube, cylinder and beam specimens are cast as per the mix ratio.

B. COMPRESSIVE STRENGTH TEST

Mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compression-testing machine by a gradually applied load. Here cube of size 150x150x150 mm casted and cured.The obtained results are tabulated below

Compressive Strength = Load/Area N/mm^2

Table7:- Average compressive strength(N/mm^2)

Grade of concrete	used % of red mud	Compressive strength N/mm^2
M30	0	33.3
	5	33.42
	10	34.15
	15	36.12
	20	38.5
	25	35.32

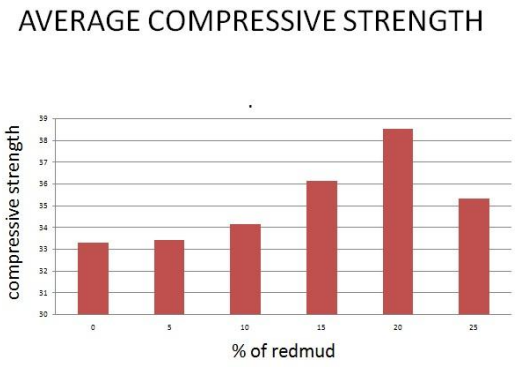

Figure1: COMPRESSIVE STRENGTH

C. SPLIT TENSILE TEST

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cylinder of size 150 mm dia and 300mm height are casted and cured. The obtained results are tabulated below

Split tensile strength =2p/πdl N/mm^2

Table8:- Average split tensile strength

Grade of concrete	used % of red mud	Split tensile strength(N/mm2)
M30	0	45.031
	5	45.09
	10	46.01
	15	46.87
	20	48.39
	25	46.37

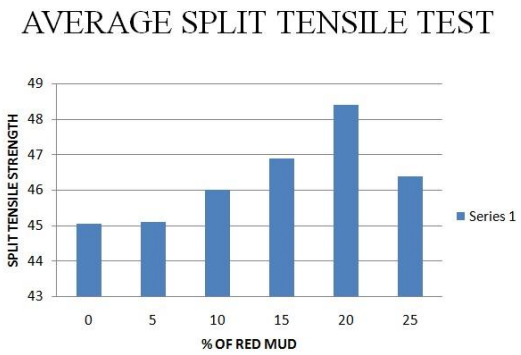

Figure2: SPLIT TENSILE TEST

VII. 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 20%.By this replacement results got are nearly equal to the results of controlled concrete.

3.Workability of concrete may get affected with increase of red mud but it can be improved by adding superplastcizers.

4.The decrease in initial setting time at 5% and 10% may be due to the light weight of neutralized red mud and finer particles of mud which fills the voids of the cement by which there may be increase in the density of the mix.

4.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.

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