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An Experimental Investigation on the Properties of Red Mud Fibre Reinforced Concrete

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Abstract *Concrete technologists throughout the world are making constant efforts to find innovative materials which can partially or fully replace the extensively used energy consuming building material, cement. To avoid the environmental and ecological damages caused by quarrying and exploitation of the raw materials for the manufacture of cement apart from the carbon foot prints in the manufacturing process. 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 cementations 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.*

Key Words: Red Mud, *environmental, Ecological damages, carbon foot, partially replace, percentage.*

1. Introduction

Concrete technologists throughout the world are making constant efforts to find innovative materials which can partially or fully replace the extensively used energy consuming building material, cement. Use of industrial wastes like Red Mud, Fly Ash, Silica Fume, Ground Granulated Blast Furnace Slag, Metakaolin, Rice Husk Ash, which possess pozzalonic property are being tried to replace cement partially. Substituting waste byproduct materials will conserve dwindling resources and will avoid the environmental and ecological damages caused by quarrying and exploitation of the raw materials for the manufacture of cement apart from the carbon foot print in the manufacturing process. The output of these waste materials suitable as cement replacement such as slag, fly ashes, rice husk ash etc. is more than double that of cement production.

Red Mud is a solid waste product of the Bayer process, the principal industrial means of refining bauxite in order to provide alumina as raw material for the electrolysis of aluminum by the Hall-Heroult process. Several years ago, a few investigators abroad showed interest in the relation between grain size and flocculation settling, as well as in the geotechnical analysis of Red Mud. Domestic research focused largely on flocculation settling and ways of disposal according to grain shape. The tests on basic properties of Red Mud with the definition of the size dimension given our rheological constitutive relations.

Physical Properties of Red Mud:

1) Generally Fineness of Red Mud varies in the range of 1000-3000 cm^2/gm. Red Mud samples are collected from Hindalco Industries Limited, Belgaum, Karnataka (INDIA). In this study Red Mud passing through 300 micron I.S. Sieve has been taken for replacement of cement.
2) Its PH varies in from 10.5 to 12.5 hence it is alkaline in nature.
3) Specific gravity of Red Mud is found to be 2.51.

1.1 Fibres in Concrete

Fibers are usually used in concrete to control plastic shrinkage cracking and drying shrinkage cracking and increase in strength. They also lower the permeability of concrete and thus improving durability. Some types of fibres produce greater impact, abrasion and shatter resistance in concrete.

2. Objective of the Study

The main objective of this experimental investigation is to find out the effect of replacement of cement by Red Mud on the properties of concrete. The cement is replaced by Red Mud in different proportions such as 0%, 2%, 4%, 6%, 8%, 10%, 12%, 14%, 16%, 18% & 20% along with Galvanized Iron fibres for 0.5% and 1% of volume fraction. The concrete is cured for 28 days. After curing the concrete specimens of hardened concrete are tested for their compressive strength, tensile strength and shear strength. Also additional tests such as workability test like slump test is done.

The present work is limited to the study of effect of Red Mud blended galvanized iron fibre reinforced concrete, only on its strength characteristics. Limiting the fibre content to 0.5% and 1%. The Red Mud is blended in cement in fraction 2-20% in intervals 2%

3 Materials Used

3.1 Cement

In this experimental work 43 grade Ultra Tech cement is used for all concrete mixes. The cement used is fresh and without any lumps. The testing of cement is done as per IS: 8112-1989. Various properties of cement as given the manufacturer is shown in table 1. The Specific gravity of cement has been determined in the laboratory as per IS code and is found to be 3.15.

Table 1 Properties of Cement

Sl no	Particulars	Experimental results	As per standard
1	Normal consistency (%)	33	28-35
2	Fineness	225 m^2/kg	Not less than 225 m^2/kg
3	Setting time (minutes)	-	-
	Initial	183	Not less than 30 mins
	Final	289	Not more than 600 mins
4	Temperature during testing	28° C	27° C ±2%

3.2. Aggregate

M-Sand used as fine aggregate in this experimental work passes through 4.75 mm size sieve is used in the preparation of specimens. The sand conforms to grading Zone II as per IS: 383-1970. The specific gravity of 2.3 as found in the laboratory.

The coarse aggregate used in the investigation is 20 mm down size locally available crushed granite stone obtained from quarries. Course aggregates have to conform to I.S. 383-1970. The specific gravity of coarse aggregate is found to be 2.82.

3.3. Red Mud

The Red Mud used for the replacement of cement is obtained from Aluminum industry HINDALCO, Belgaum. It is obtained from Bayer's process. The characteristics of Red Mud depend on the nature of the bauxite ore used. The specific gravity of Red Mud is determined in the laboratory and is found to be 2.93.

Composition of Red Mud

Chemical properties of Red Mud are shown in table 2. The CaO content is very low in Red Mud hence it has no cementitious properties but when it react with water and cement it starts gaining cementitious properties. Also presence of Silica contributes to strength.

Table 2: Chemical composition of Red Mud

Components	Weight %
Al_2O_3	20-22
Fe_2O_3	40-45
SiO_2	12-15
TiO_2	1.8-2.0
CaO	1.0-2.0
Na_2O	4-5

3.4. Water

The water used in the mix design is potable water and it is free from suspended solids and organic materials. The water used for both mixing and curing of concrete should be free from impurities, injurious amounts of acids, alkalis, oils, salts, organic matter or other substances that may be deleterious to concrete or steel. The water should be colourless and odourless. The presence of chlorides and sulphates are injurious to reinforcing bars as they may be corroded. The general required of water for mixing and curing concrete shall be as per IS 456- 2000.

3.5. Super Plasticizer

Super Plasticizers are workability agents used to improve handling and compacting of mixes. Complots SP 430 is used as a super plasticizing admixture. Conplast SP430 is a based on sulphonated naphthalene polymers and is supplied as a brown liquid instantly dispersible in water. Conplast SP 430 has been specially formulated to give high water reductions unto 25% without loss of workability and produce high quality concrete of reduced permeability.

3.6. Galvanized Iron Fibre (GI Fibre)

The GI wire is readily available in market in various gauges. In this work the used GI wire is of 1mm diameter and it is cut into small pieces of 50mm length. The density of GI fibre is 78.50kN/m^3. GI fibre is mixed in concrete according to the volume fraction, i.e.; 0.5% and 1% of specimen.

Table 6: Mix proportion for M30 grade concrete

W/C ratio	Cement	Fine aggregate	Coarse aggregate
0.40	390.6	626.7	1253.6
0.40	1	1.604	3.21

4 Results & Discussions

A total of 198 test specimen have been cast to carryout Compressive, Tensile and Shear strength tests have been carried out on 20 concrete mixes starting from three Reference mixes,

1) Design mix for plain cement concrete
2) Design PCC with 0.5% GI fibres and
3) Design PCC with 1% GI Fibres.

4.1 Compressive Strength

Standard Cube Specimens of dimensions 150x150x150mm were cast and cured for 28 days in immersion tank. They are tested on 3000 kN capacity compression testing machine as per IS 516-1959.

Fig 1: Compressive strength

Table and Graph shows the 28 days compressive strength of red mud concrete cubes.

Table 3: Test results of compressive strength

% replacement of cement by RM	Red Mud with 0.5% GI-FRC (MPa)	Red Mud with 1% GI-FRC (MPa
Ref. mix PCC	40.74	40.74
2	40.88	43.11
4	41.92	44.15
6	43.55	45.48
8	46.67	48.44
10	44.44	46.37
12	44.30	44.44
14	43.40	43.70
16	41.77	42.52
18	40.30	41.63
20	38.51	40

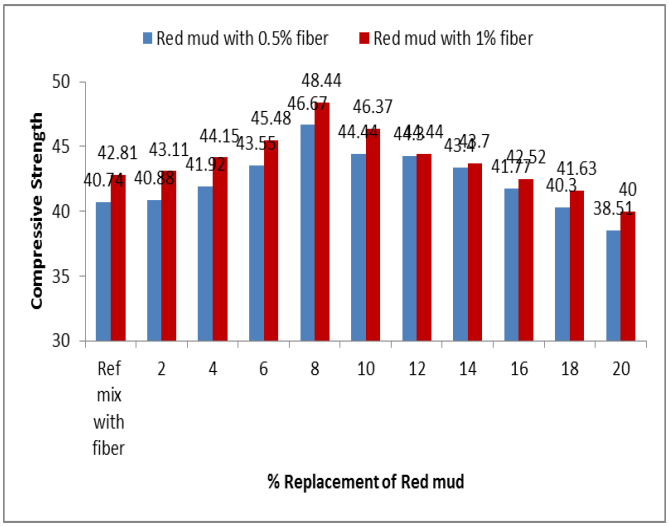

Fig 2: Variation of compressive strength

It can be observed that the compressive strength of FRC Red Mud concrete has shown maximum increase in strength for both 0.5% and 1% of GI fiber content at 8% replacement of Red Mud. The increase is 14.55% for 0.5% of GI-FRC and 18.90 for 1% GI-FRC.

4.2 Split tensile Strength Test

Cylindrical specimens of diameter 150mm and length 300mm were prepared. Split tensile test was carried out on 3000 kN capacity compression testing machine as per IS 5816-1999.

Fig 3: Split Tensile strength

Table 4: Test results of Split Tensile Strength

% replacement of cement by RM	Red Mud with 0.5% GI-FRC (MPa)	Red Mud with 1% GI-FRC (MPa
Ref. mix PCC	2.92	2.92
2	2.83	3.37
4	3.12	3.68
6	3.48	3.99
8	4.02	4.51
10	3.91	4.30
12	3.82	4.15
14	3.44	3.73
16	3.06	3.42
18	2.69	3.12
20	2.50	3.01

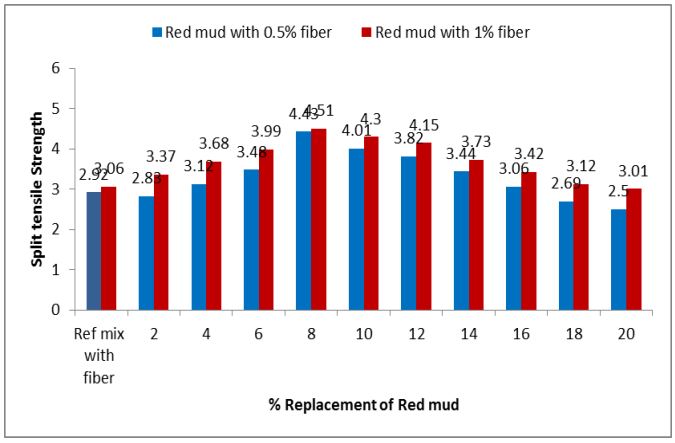

Fig 4: Variation of Split Tensile Strength

It can be observed that the split tensile strength of FRC Red Mud concrete has shown maximum increase in strength for both 0.5% and 1% of GI fibre content at 8% replacement of Red Mud. The increase is 37.67% for 0.5% GI-FRC and 54.45 for 1% GI-FRC.

4.3 Shear Strength Test

L shaped specimens were prepared as per ASCE publication journal, Vol 03, pp. 48-51 as shown in fig.10. These specimens were tested on 3000 kN capacity compression testing machine. A loading arrangement was made such that a direct shearing force was applied on the shorter arm of the 'L' shaped specimen (i.e. over an area of 150mm x 60mm).

Fig 5: Shear strength

Table 5: Test results of Shear Strength

% replacement of cement by RM	Red Mud with 0.5% GI-FRC (MPa)	Red Mud with 1% GI-FRC (MPa
Ref. mix PCC	5.37	5
2	5.74	6.31

4	6.30	6.93
6	6.85	7.74
8	7.22	7.85
10	7.04	7.54
12	6.11	6.31
14	5.74	6.52
16	5.56	5.91
18	4.81	5.30
20	4.07	4.69

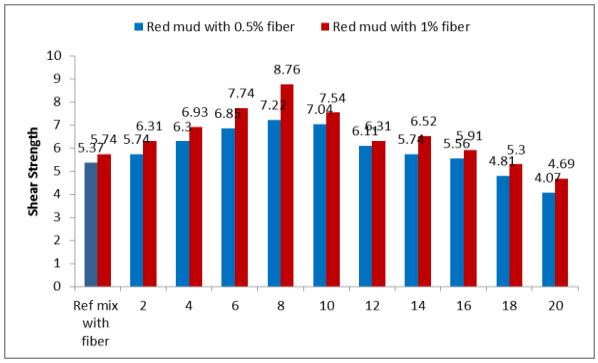

Fig 6: Variation of Shear Strength

It can be observed that the shear strength of FRC Red Mud concrete has shown maximum increase in strength for both 0.5% and 1% of GI fibre content at 8% replacement of Red Mud. The increase is 34.45% for 0.5% of GI-FRC and 46.74% for 1% GI-FRC.

5.Conclusion

The following conclusions are drawn by analysing test results of various strength tests.

- Red Mud replaced FRC has shown increase in compressive strength when compared to FRC without Red Mud for both fibre content of 0.5% and 1% up to 8% Red Mud content. Beyond that it decreases with increase in Red Mud content. The increase is 14.55% and 18.90 % for 0.5% and 1% GI-FRCs respectively.
- Red Mud replaced FRC has shown increase in Split Tensile strength when compared to FRC without Red Mud for both fibre content of 0.5% and 1% up to 8% Red Mud content. Beyond that it decreases with increase in Red Mud content. The increase is 37.67% and 54.45 % for 0.5% and 1% GI-FRCs respectively.
- Red Mud replaced FRC has shown increase in Shear strength when compared to FRC without Red Mud for both fibre content of 0.5% and 1% up to 8% Red Mud content. Beyond that it decreases with increase in Red Mud content. The increase is 34.45% and 46.74% for 0.5% and 1% GI-FRCs respectively.
- It is observed that increase in Red Mud content will decreases the compressive, split tensile and shear strength of concrete. This is probably due to loss of workability.

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References

1. Ramesh R. Rathod , Nagesh T.Suryawanshi ,Pravin D. Memade, “Evaluation of the properties of Red Mud Concrete”, (2014), American Journal of Engineering Research (AJER)

2. Priti A. Patel1, Dr. Atul K. Desai and Dr. Jatin A. Desai "Evaluation Of Engineering Properties For Polypropylene Fibre Reinforced Concrete” International Journal of Advanced Engineering Technology E-ISSN 0976-3945,

3. Priti A. Patel1, Dr. Atul K. Desai and Dr. Jatin A. Desai "Evaluation Of Engineering Properties For Polypropylene Fibre Reinforced Concrete” International Journal of Advanced Engineering Technology E-ISSN 0976-3945,

4. Sunitha M.Pujar, Dr.K.B.Prakash (2013) in their paper entitled, “Effect Of Replacement Of Cement By Red Mud On The Properties Of Concrete”.

5. IS 456:2000 “Indian Standard code of Practice for Plain and Reinforced Cement Concrete”, Bureau of Indian Standards, New Delhi.

6. IS 10262:2009 “Concrete Mix Proportioning”, Bureau of Indian Standards, New Delhi.

7. IS 383:1970 “Specification for Coarse and Fine Aggregates from Natural Sources for Concrete”, Bureau of Indian Standards, New Delhi.