DEVELOPMENT OF RED MUD CONCRETE AND ITS STRUCTURAL APPLICATIONS

Ravi Kumar Singh1, ,Pushpendra Kumar Kushwaha2,Jiji M Thomas 3,Mithun Kumar Rana 4

M.Tech Research Scholar1, Assistant Professor2,3,4

Civil Department

RKDF College of Engineering Bhopal, India

ABSTRACT

The population growth rate is being increased day by day as well increasing the needs of people, which leads to the development of a lot of new industries. Solid wastes from the industries make serious environment issues. Red mud is one of the solid wastes obtained from aluminum industry. Cement is an important ingredient and a binder in the manufacturing of concrete. But its production releases a large amount of CO2 to the atmosphere thus degrading the environment. This can be prevented by conserving the use of cement by replacing partially with waste materials. One such material is an industrial waste called red mud.A mix proportion of 1:1.4:2.6was adopted to obtain a target compressive strength of 30 MPa. The compressive strength increased with the increase in the percentage of red mud attaining a peak value at a replacement percentage of In the preparation of concrete calcium chloride was added as an accelerator to hasten hardening of concrete. In another batch of concrete retarder was added to delay setting of concrete.

Keywords: Concrete, cement, red mud, partial replacement, compressive strength, structural applications, , testing, admixtures

INTRODUCTION

Concrete is the primary construction material used around the world and most widely used in all types of civil engineering works and it is a manmade product, essentially consisting of cement, aggregate, water and admixtures. Concrete in spite of being the most popular and most economical construction material has major shortcomings in terms of embedded energy and is also one of the major causes of greenhouse gas effect. However, the production of cement of leads to the dissipation of significant amount of carbon dioxide and greenhouse gas emission.

One ton of Portland cement clinker production creates one ton of carbon dioxide and other greenhouse gases. To reduce the emission of carbon dioxide concerning the production of cement, we must reduce the usage of cement, and therefore the demand of Portland cement. Therefore, there is a need to look for alternate types of material the carbon dioxide emissions associated with the manufacturing of Portland cement can be reduced significantly by reducing the production of current clinker. In this project loss in production of Portland cement can be overcome the increased use of red mud in different percentages super plasticizers.

RED MUD

Red mud is the composed of a mixture of solid and metallic oxide-bearing impurities, and presents one of the aluminium industry's most import disposal problems the red mud caused by the oxidized iron present which can make up to 60% of the mass of the red mud. In addition to iron the other dominant include silica unleashed residual aluminium, and titanium oxide. Red mud cannot be disposed of easily. As a waste product of the Bayer process the mud is highly basic with a pH ranging from 10 to 13. The following is the composition of the dry red mud of MALCO.

INTRODUCTION TO RED MUD CONCRETE

Due to the rapid industrialization, a huge quantity of waste products is discharged into the atmosphere, which causes the environmental hazards. The wastes thus discharged can be used in construction as a replacement material for conventional materials, when utilized in a good way.

The waste material generated as a byproduct of Bayer's process from aluminum industry is called red mud. Since it is a highly caustic chemical substance, which causes contamination of ground water leading to health hazards, it should be dispersed in a proper way. The disposal of such materials is a major problem to these industries.

LETERATURE REVIEW

RED MUD AS POZZOLAN

Waste materials that are commonly used for replacing cement are kaoline, Ground Granulated Blast Furnace Slag (GGBFS), fly ash (FA), rice husk ash (RHA), etc. Along with

these, one more waste material from the industry, namely, red mud is also available as pozzolan. This waste is a result of the Bayer process of the extraction of aluminium from bauxite ore. This process is characterized by low energy efficiency (Balomenos et al. 2011). The global production of red mud is 117 million tonnes per annum (Kumar &Nayak 2015). The colour and name of this waste are derived from its iron oxide content. Generally, for every 3 tonnes of bauxite approximately 1 tonne of alumina is generated. Besides, from every 2 tonne of alumina about 1 tonne of aluminiumis attained. According to Metilda et al. (2015), approximately, 0.3 – 1.0 tonne of red mud is created for every tonne of alumina produced. Globally, less than half of the red mud produced by aluminium industries is consumed and the remaining quantity is dumped in landfill (Rout et al. 2012).

OBJECTIVE

To find the compressive strength, split tensile strength and flexural strength of red mud used concrete and conventional concrete.

- find the optimum replacement of cement by red mud.
- To compare the compressive strength, split tensile strength and flexural strength of the red mud concrete with the conventional concrete.

MATERIALS AND METHODS

MATERIALS USED IN EXPERIMENT

Corse Aggregate

Fine Aggregate

Red Mud

Cement

Admixtures I

Accelerator

Accelerator

Water

TEST PROCEDURE

Slump Cone Test

The test measures consistency of concrete in that specific batch. It is performed to check consistency of freshly made concrete. Consistency refers to the ease with which concrete
flows.

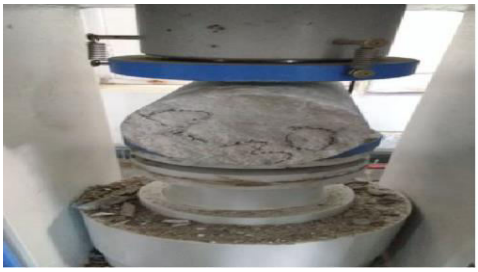
Test Specimens

Totally 60 cubes (60 for M30) of size 150 mm x 150 mm x 150 mm and were cast to study the compressive strength of red mud concrete. Standard cast iron mouldswereused for casting the test specimens

Compressive strength of red mud concrete equipment

Split Tensile Strength

Totally 30 cylinders (30 for M30) having a diameter of 150 mm and 300 mm length were cast to evaluate the split tensile strength of red mud concrete. Standard cast ironmouldswere used for casting the test specimens.



Split tensile strength of red mud concrete equipment

Flexural Strength

Totally eighteen prisms of size 500mmx100mm x100 mm were cast to study the flexural strength of red mud concrete. Standard cast iron mouldswere used for casting the test specimens.

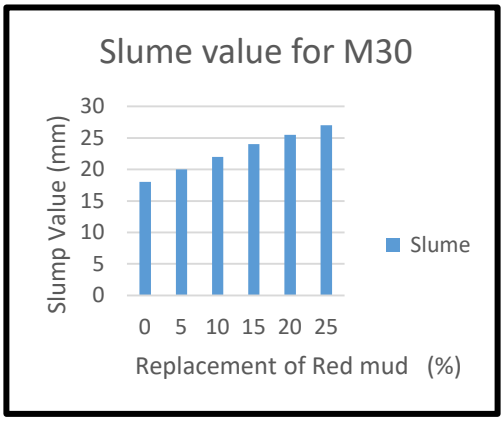
Flexural strength of red mud concrete equipment

RESULTS AND ANALYSIS

Workability Test

Slum value for M30

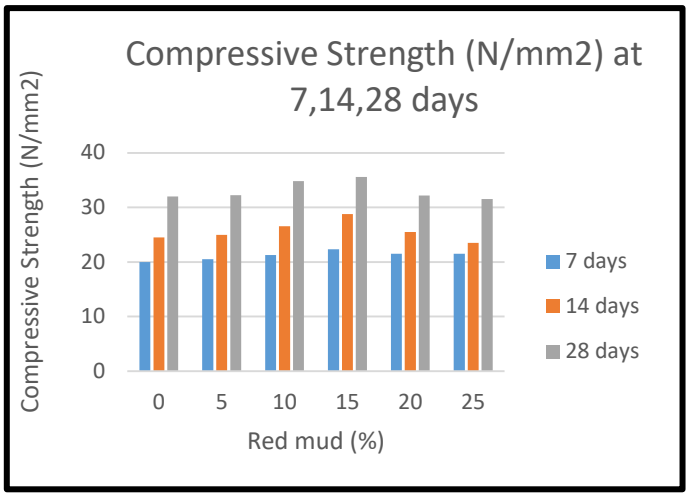
Samples	Sand in %	Course aggegate in %	Cement in %	Replacement of Red mud (%)	Slump Value (mm)
CS	100	100	100	0	18
R1	100	100	95	5	20
R2	100	100	90	10	22
R3	100	100	85	15	24
R4	100	100	80	20	25.5
R5	100	100	75	25	27



COMPRESSIVE STRENGTH TEST

Compressive Strength of Different Mix of M-30 Concrete

Specimen designation	Red mud (%)	Compressive Strength (N/mm2)		
		7 days	14 days	28 days
CS	0	20	24.5	32
R1	5	20.5	24.95	32.25
R2	10	21.25	26.52	34.8
R3	15	22.35	28.8	35.6
R4	20	21.5	25.5	32.2
R5	25	21.5	23.5	31.5



Compressive Strength of Different Mix of M-30 Concrete at 7,14 and 28 days

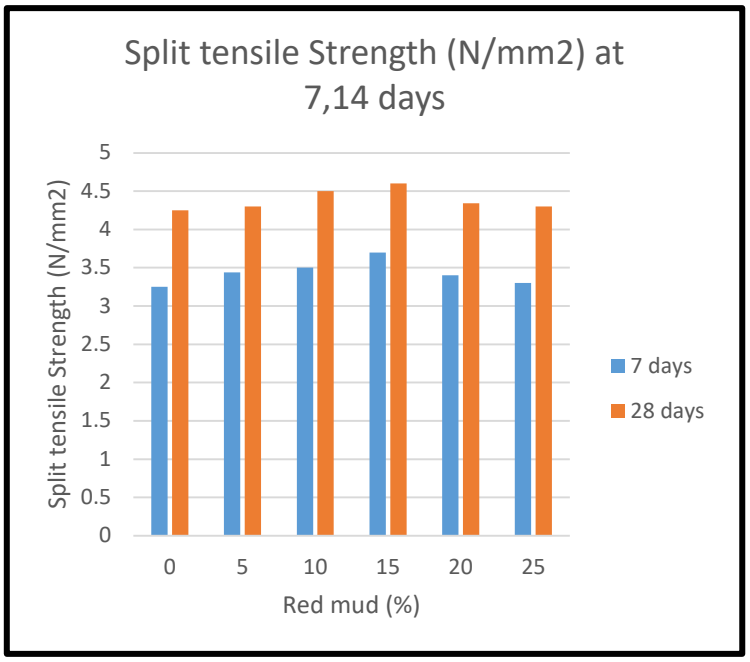
Disussion: From the above table is seen that the compressive strength with 15% cement replace by Red mud in M 30 grade of concrete at 7, 14 and 28 days increases when the percentage of

the red mud increase from 15% to 25% then the strength decrease .comcreteachive maximum strength at 15 % of red mud replacement at 28 day ,From all the above basic test results it was concluded that 15% substitute of red mud in concrete is the optimum value which gives the highest strength to concrete.Therefore it was decided to use this concrete containing 15% red mud in casting structural joints. Along with these control concrete joints were also prepared for testing and for comparison of results.

SPLIT TENSILE STRENGH TEST

Split Tensile strength of Mix of M-30 Concrete

Specimen designation	Red mud (%)	Split tensile Strength (N/mm2)	
		7 days	28 days
CS	0	3.25	4.25
R1	5	3.44	4.3
R2	10	3.5	4.5
R3	15	3.7	4.6
R4	20	3.4	4.34
R5	25	3.3	4.3



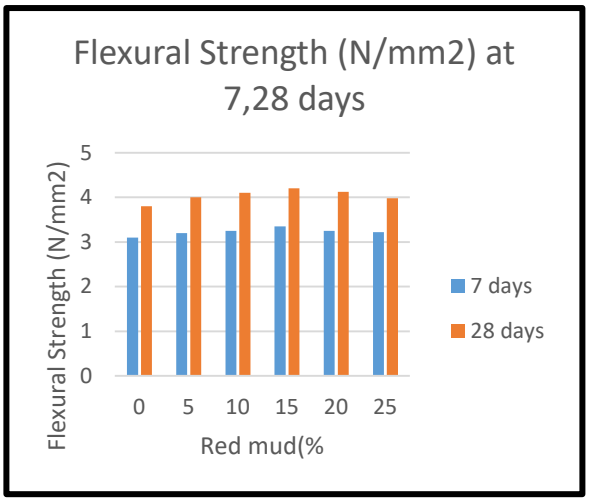
Split tensile strength of Mix of M-30 Concrete at 7 and 28 days

From all the above basic test results it was concluded that 15% substitute of red mud in concrete is the optimum value which gives the highest strength to concrete. Therefore it was decided to use this concrete containing 15% red mud in casting structural joints. Along with these control concrete joints were also prepared for testing and for comparison of results

FLEXURE STRENGH TEST

Flexure strength of mix of m-30 concrete

Specimen designation	Red mud (%)	Flexural Strength (N/mm2)	
		7 days	28 days
CS	0	3.1	3.8
R1	5	3.2	4
R2	10	3.25	4.1
R3	15	3.35	4.2
R4	20	3.25	4.12
R5	25	3.22	3.98



Flexure strength of mix of m-30 concrete at 7 and 28 days

From all the above basic test results it was concluded that 15% substitute of red mud in concrete is the optimum value which gives the highest Flexural strength to concrete. Therefore it was decided to use this concrete containing 15% red mud in casting structural joints. Along with these control concrete joints were also prepared for testing and for comparison of results.

CONCLUSION

The value of the compressive strength of concrete was found to be the highest at the level of 15% replacement of red mud.

The maximum compressive strength of concrete with 15% red mud content was 36.6 N/mm2 as against 32.00 MPa for control concrete.

The split tensile strength of cylinder was 4.60 N/mm2 with 15% red mud concrete as against 4.38 N/mm2 for control concrete.

The flexural strength of prism was 4.23 N/mm2 with 15% red mud concrete as against 3.8 N/mm2 for control concrete. So the optimum replacement level for cement by red mud was 15%.

REFERENCE

1. Aggarwal, P, Aggarwal, Y & Gupta, SM 2007 'Effect of bottom ash as replacement of fine aggregates in concrete,' Asian Journal of Civil Engineering (Building and Housing), vol. 8, no. 1, pp. 49-62.

2. AL-Jumaily, IAS & Kareem, NNQ 2015, 'An overview on the influence of pozzolanic materials on properties of concrete,' International Journal of Enhanced Research in Science Technology & Engineering, vol. 4, no. 3, pp. 81-92.

3. Ashok, P &Sureshkumar, MP 2014, 'Experimental studies on concrete utilizing red mud as a partial replacement of cement with hydrated lime,' IOSR Journal of Mechanical and Civil Engineering, ISSN 2278- 1684, pp. 01-10.

4. AssociaçãoBrasileira de NormasTécnicas – NBR 10004, 1987, 'ResiduousSólidos - Classificação', Rio de Janeiro.

5. Balomenos, E, Gianopoulou, I, Panias, D, Paspaliaris, I & Perry, K 2011, 'Efficient and complete exploitation of the bauxite residue (redmud) produced in the Bayerprocess', Proceedings of EMC., pp. 745-757.

6. Bangesh 1989, Huyse et.al 1994 ANSYS 1998. Finite element analysis on the flexural.

7. Bhaskar, M, Akhtar, S &Batham, G 2014, 'Development of the bricks from red mud by industrial waste (red mud),' International Journal of Emerging Science and Engineering, vol. 2, no. 4, pp. 7-12.

8. Bishetti, PN &Pammar, L 2014, 'Experimental study on utilization of industrial waste in concrete,' International Journal of Technical Research and Applications,' vol. 2, no. 4, pp. 49-52.

9. BS: 8110 - Part 1 1985, Structural use of concrete: code of practice for design and construction, British Standards Institution, London.

10. BS : 5075 – Part I (1982), Concrete Admixtures specifications for Accelerating Admixtures Retarding Admixtures & water reducing admixtures.

11. Chatveera, B &Lertwattanaruk, P 2011, 'Durability of conventional concretes

containing black rice husk ash,' Journal of Environmental Management, vol. 92, pp. 59-66.

12. Cherian, MR & Praveen, M 2014, 'Structural applicability of recycled concrete with both recycled coarse and recycled fine aggregate,' International Journal of Innovative Research in Advanced Engineering (IJIRAE), vol. 1 issue 9, pp. 231-235.

13. Deelwal, K, Dharavath, K &Kulshrestra, M 2014, 'Evaluation of characteristic of red mud for possible use as a geotechnical material in civil construction,' International Journal of Advances in Engineering & Technology, vol. 7, Issue 3, pp. 1053-1059.

14. Deotale, RS, Sathawane, SH &Narde, AR 2012 'Effect of partial replacement of cement by fly Ash, rice husk ash with using steel fiber in concrete,' International Journal of Scientific & Engineering Research, vol. 3, no. 6, pp. 1- 8.

15. Desayi& Krishnan 1964 'Stress – Strain Relationship for Concrete in Compression'.

16. Deshmukh, MP &Sarode, DD 2014, 'Bulk utilization of industrial waste (bauxite residue) for production of red mud concrete, IOSR Journal of Mechanical and Civil Engineering, vol. 11, no. 6, pp. 1-3. 17. Gere and Timoshenko 1997, 'Mechanics of Materials James, M, Gere, Stephen. P,

18. German standard for determination of Permeability.

19. Elsayed, AA 2011, 'Influence of silica fume, fly ash, super pozzalonand high slag cement on water permeability and strength of concrete,' Jordan Journal of Civil Engineering, vol. 5, no. 2, pp. 245-257.

20. Guide of the ACI Committee 212 3R – 91 (1994), 'Chemical) Admixtures for Concrete – DrFathollahSajedi.

21. Hanayneh, B, Shatarat, N &Katkhuda, H 2012, 'Improving durability of concrete to phosphoric acid attack,' Jordan Journal of Civil Engineering, vol. 6, no. 1, pp. 68-82.

22. IS: 383, 1970, Indian Standard specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards, New Delhi.

23. IS: 456, 2000, Indian Standard plain and reinforced concrete – code of practice,

Bureau of Indian Standards, New Delhi, 100.

24 IS: 8112, 2013, Indian Standard S\specification for Ordinary Portland Cement, 43 Grade Specification, Bureau of Indian Standards, New Delhi.

25. IS: 9103, 1999, Indian Standard for concrete admixtures - specification, Bureau of Indian Standards, pp. 11.

26. IS: 10262, 2009, Indian Standard concrete mix proportioning – guidelines, Bureau of Indian Standards, New Delhi, 14.

27. IS: 516, 1959, 2004 Indian Standard methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi, 24 pp. Reaffirmed in.

28. King, D 2012, 'The effect of silica fume on the properties of concrete as defined in Concrete Society report 74, cementitious materials,' 37th Conference on Our World in Concrete & Structures, Singapore, vol. 29-31 , pp. 1-22.

29. Kumar, MSK &Nayak, R 2015, 'Experimental study on utilization of industrial wastes (red mud and copper slag) in mortar,' International Journal of Engineering – on line, vol. 3, Issue 4, pp. 204-208.

30. Kushwaha, M Akhtar, S, Rajput, S, 2013, 'Development of the self compacting concrete by industrial waste (red mud),' International Journal of Engineering Research and Applications, vol. 3, no. 4, pp. 539-542.

31. Metilda, DL, Selvamony, C, Anandakumar, R &Seeni, A 2015, 'Investigations on optimum possibility of replacing cement partially by red mud in concrete,' Scientific Research Essays, no. 10, no. 4, pp. 137-145.

32. Mondal, BC, Uddin, N & Amin, I 2011, 'A study on sulfuric acid attack on cement mortar with rice husk ash,' 4th Annual Paper Meet and 1st Civil Engineering Congress, Dhaka, Bangladesh, Noor, Amin, Bhuiyan, Chowdhury and Kakoli (eds), pp. 44-49.

33. New concrete society publication cementitious materials CSTR 74 ; The effect of silica fume on the properties of concrete as CI – Premier Ptc. Ltd.