Review on Strength Properties of M20 and M30 Concrete with Partial Replacement of Cement by Red Mud

Akshay Daharwa[l] Pushpendra Kumar Kushwaha[2] Jiji M Thomas[3]
[1]M.Tech Research Scholar [2,3]Assistant Professor
[1,2,3]Department of Civil Engineering
[1,2,3]RKDF College of Engineering Bhopal, India

Abstract— Extensive amounts of waste materials and by-products are generated by human, industrial and commercial activities. It has become difficult to handle huge amount of waste which leads to environmental problems. Rapid utilization of natural resources, generation of huge amount of industrial wastes and environmental pollution needs new solution for sustainable economic development. During past decades more concern is shown towards the utilization of industrial wastes and by-products in civil engineering works. Utilizing the waste is a partial solution to ecological and environmental problems. The main objective of the study to solves this disposal problem red mud is used in manufacturing of concrete. The use of Red Mud and hydrated lime may also helpful for reducing the solid waste which is a course of environmental.

Keywords: Red mud, Hydrated Lime, Compressive Strength Test, Split tensile Strength test

I. INTRODUCTION

Concrete is a versatile building material. It is arranged using cement, crushed stone, water and river sand. These ingredients are weigh batched in required proportions and mixed thoroughly using a mixture machine. Cement is an important binder in concrete and its production releases CO2 to atmosphere thus causing environmental pollution. Therefore its consumption has to be reduced with the substitution of pozzolanic material which is thrown as a waste by industries. One such waste is red mud obtained by Bayer process in the extraction of bauxite in the aluminium industries that is discharged into landfill nearby the industries. About 1 ton of alumina is created from 3 tons of bauxite and about 1 ton Aluminum is generated from 2 tons of alumina. The removal of red mud pollutes land and the ground water. To avoid such problems it is converted in to building materials. Red mud is used in two ways, either in the production of ordinary Portland cement as a source of iron oxide or alumina, or in the raw mix of special cements. Red mud is a good source of Fe2O3 for cement raw mix, but modifies somewhat the microstructure of the clinker. Using red mud for the production of bricks is a simple and economical method to utilize this waste material. The addition of red mud, replacing 30% of sand exhibits higher strengths than concrete with quartz aggregates for in built-in piles and have a better durability, than standard concrete in defined conditions. Therefore in this experimental investigation red mud has been used as a cement replacement material in the production of concrete.

II. LITERATURE-REVIEW

This chapter discussed about the literature review for red mud. In this some studies related to characterization of red mud as construction material, Many works have been carry out to explore the benefits of using various waste materials such as GGBS, Fly ash , stone dust and glass powder in making and enhancing the properties of concrete. The work done by various authors describe below

A. Literature review on applications of red mud as construction material

Kalkan (2006) examined the effects of red mud on the unconfined compressive strength, hydraulic conductivity, and swelling percentage of compacted clay liners as a hydraulic barrier. The test results showed that compacted clay samples containing red mud and cement–red mud additives had a high compressive strength and decreases the hydraulic conductivity and swelling percentage as compared to natural clay samples. The addition of these additives changed the soil groups from high-plasticity soil group (CH) to low-plasticity soil group (MH). Consequently, it was concluded that red mud and cement–red mud materials can be successfully used for the stabilization of clay liners in geotechnical applications.

Desai and Herkal (2010) Effectively utilized red mud in making burnt and unburnt bricks in pressed and undressed conditions. Red mud bricks with additives like lime, sand, recron fibers of6mm &12mm length were prepared and tested. Unpressed bricks with recron fibers (6mm & 12mm) give good strength but just pressing the bricks to proctor density, almost doubles the strength. Based on the optimum percentage of fiber and cost, 12mm recron fibers can be cost effective. Burning of red mud bricks do not show any improvement in the strength. Therefore, unburnt pressed red mud bricks with 10 percent of sand or with 12mm recron fibers can be effectively used for low cost houses and interior in filled walls.

VenuMalagavelliet. al. 2010 'High performance concrete with GGBS and robo sand'

Ribeiro et al. (2011) studied on non-calcined red mud which requires less energy and time and reducing costs, which is the ideal condition for reusing wastes. In this research mortars containing30 wt. (%) of cement substituted by red mud showed higher strength of hardened products. Thepozzolanic activity index was evaluated based on physical and mechanical parameters (BrazilianNBR 5751 and NBR 5752 standards) and on a chemical analysis (European EN 196-5 standard).Then a comparison of the reference mixture (without red mud) and the results obtained with redmud confirms the potential of non-calcined red mud for use a as pozzolanic additive incementitious materials.

Khan et al. (2012) utilized the waste from alumina refinery plant such as red mud in production of ceramic tiles. Pyrophyllite mineral had been added to the red mud to improve the strength properties. The tiles are produced at lower temperature (950-1000oC) then the conventional process of making ceramic tiles and without addition of

phosphatic binders. The structural features of red mud had been studied using scanning electron microscope which provides reinforcement to the ceramic tiles matrix.

Mrs. Veena G. Pathan, et al, (2012) 'Evaluation of concrete properties using ground granulated blast Furnace slag'

Satayanarayana et al. (2012) studied red mud stabilized with 2, 4, 6, 8,10 and 12 percentages of lime and unconfined compressive strength, Split tensile strength and California bearing ratio test swere conducted at 1, 3, 7 and 28 days curing periods respectively. From the experimental findingsit was observed that 10% lime has shown higher values compared to other percentages. At 28 days it has shown maximum values than other curing periods for all percentages of lime. The CBR value obtained for 10% lime at 28 days is 25%, hence it can be used as subgrade and sub base material in road construction.

Wang and Liu (2012) studied compositions and XRD patterns of the two kinds of red mud and showed that CaCO3 content in Sintering red mud is significantly higher than in Bayer red mud. So it will be more applicable in the production of cement. The micro particle of Bayer red mud was finer and more disperse, but the Sintering red mud has higher shear strength. Combining the TG and hydraulic characteristics analysis, it can be shown that Bayer red mud has higher value of water content and Sintering red mud has higher hydraulic conductivity. The paper then illustrated that Sintering red mud can become the main filling material of supporting structure of red mud stocking yard. Bayer red mud has a high reuse value and also can be used as a mixing material of masonry mortar.

Rout et al. (2012) designed high embankment using red mud based on the laboratory geotechnical investigation and the stability analysis using finite element analysis. To protect the dispersive red mud against external weathering it was recommended to cover it with local soil. The embankment with soil cover was found to have more than required FOS value. The embankments were also analyzed considering concentrated load and the load with vibration. The FOS is found to decrease with static and vibration load.

Sawant et al. (2012) have stated that optimum utilization of neutralized red mud (NRM) in concrete was 15% as a partial replacement of cement.

Arhin et al. (2013) studied the applicability of red mud in the ceramic brick construction industryas a means of recycling the bauxite waste. The red mud-clay composites have been formulated as80%-20%, 70%-30%, 60%-40%, 50%-50% and fired at sintering temperatures of 800ºC, 900ºC and 1100ºC. They found that physical properties such as apparent porosity and water of absorption reduced while the mechanical strength (modulus of rupture), and the bulk densities increased at higher sintering temperature.

Neeraja.D2013"Experimental Investigations on Strength Characteristics of Steel Fiber Reinforced Concrete

Rathod et al. (2013) Investigated the possibility of replacing the Portland cement by red mud. In this study portl and cement was replaced up to 40 % RM by wt of cement. They examined the effects of red mud on the properties of hardened concrete. The test results showed that its compressive strength & splitting tensile strength decreased with increase red mud content and concluded that Optimum percentage of the replacement of cement by weight was found to be 25%.

Satyanarayana et al. (2013) discussed use of red mud bentonite mixture as clay liner. They observed that when the percentage of Bentonite increased, consistency properties such as liquid limit, plastic limit and plasticity index are increasing. It was also observed that as bentonite increases and the red soils bentonite mixes exhibit good strength at higher percentages of bentonite and the soil bentonite mixes become impervious (k <10-6cm/sec). Hence from the test data it was identified that a dosage of 10-15 percent Bentonite yields satisfactory results for the use of the remixes as liner materials

Bhaskar et al. (2014) study on Brick from red mud, Among the various systems examined red mud based bricks have shown lighter compressive strength

Deshmukh & Sarode (2014) Study Red mud as a partial substitute for fine particles in concrete .Therefore concrete cubes were cast with 0%, 7%, 14%, 21%, and 28% replacement of fine particles in concrete with red mud. From this investigation it was found that this red mud concrete gives better compressive strength

Sonali K. Gadpalliwar and R. S. Deotale.,(2014) To Study the Partial Replacement of Cement by GGBS & RHA and Natural Sand by Quarry Sand In Concrete. Sonali K. Gadpalliwar and R. S. Deotale (2014) investigated, Concrete when subjected to severe environments its durability can significantly decline due to degradation. Degradation of concrete structures by corrosion is a serious problem and has major economic implications.

VinayakAwasare and Prof.M. V. Nagendra (2014), "Analysis of Strength Characteristics of GGBS Concrete". Byconsidering those works, this work is carried out to study the durability and strength characteristics of high strength concrete with partial replacement of GGBS and fly ash underacidic environment.

Yogendra O. Patil, Dr. Arun Kumar Dwivedi (2014) Investigates and presents an experimental study of compressive and flexural strength of concrete prepared with Ordinary Portland Cement, partially replaced by ground granulated blast furnace slag in different proportions varying from 0% to 40% and concluded that the 20% replacement of cement is possible without compromising the strength with 90 days curing.

Rana & Sa the (2015) were cast Mortar cubes, they used cement with varying percentages of replacement of red mud with the addition of lime. The authors followed the same procedure for silica to find the optimum red mud replacement with addition of either lime or silica. First, mortar cubes were cast with varying percentages replacement of red mud. The red mud fractions in the mortar were 0%, 10%, 15%, 20% and 25% with the addition of lime by weight of red mud of 0%, 4%, 8% and 12%. The 7th day compressive strength of the mortar was measured by testing in the UTM (Universal Testing Machine) as per IS: 516 (1959). Afterwards, mortar cubes were prepared with varying red mud replacement such as 0%, 10%, 15%, and 20% with addition of lime by weight of red mud 0%, 10% and 20%. The 7^{th} day compressive strength was determined by testing. These results were scrutinized to get the optimum red mud content.

III. CONCLUSION

In the first part of review properties of concrete containing fly ash, GGBFS, RHA, etc., have been presented and their feasibility of making concrete has been advocated. In the second part, utilization of red mud as a partial replacement of cement has been emphasized. Literature concerning this aspect was reviewed and a case has been made out as a supplementary cementitious material. This has been enlightened with literature evidence. From this literature the gap in research has been identified and presented.

REFERENCES

[1] Kalkan, E. (2006). Utilization of red mud as a stabilization material for the preparation of clayliners. Engineering Geology, 87(3-4), 220–229.
[2] Desai, M. V. G., Herkel, R. N., (2010). Red Mud Bricks – An alternative Low Cost Building Material. 6thInternational Congress on Environmental Geotechnics, New Delhi, India.
[3] VenuMalagavelliet. al. International Journal of Engineering Science and Technology Vol. 2(10), 2010, 5107-5113
[4] Satayanarayana, P. V. V, P, G. N., Adiseshu, S., &Hanumanth, C. H. V. (2012).Characterization of Lime Stabilized Red mud Mix for Feasibility in Road Construction, 3(7), 20–26.
[5] Wang, P., & Liu, D. Y. (2012). Physical and Chemical Properties of Sintering Red Mud and BayerRed Mud and the Implications for Beneficial Utilization. Materials, 5(10), 1800–1810.
[6] Rout S., Sahoo T. and Das S.K. (2012). Utility of Red Mud as an Embankment Material. InterNational Journal of Earth Sciences and Engineering. ISSN 0974-5904, Volume 05,No.06,1645-1651.
[7] Sawant, MB, Kumthekar, VV, Diwan, KG &Hiraskar 2012,'Experimental study on partial replacement of cement by neutralizedred mud in concrete,' International Journal of Engineering andAdvanced Technology, vol. 2, no. 1, pp. 282-286.
[8] Khan, J., Amritphale, S. S., Chandra, N., & Patel, M. (2012). A novel binder-free and energyefficient process for making ceramic tiles using red mud and sericiticpyrophyllite. Indian Journal of Chemical Technology, 19(6), 420–426.
[9] Mrs. Veena G. Pathan, et al, , International Journal of Innovative Research in Science, Engineering and Technology Vol. 1, Issue 1, (2012) , pp 7179
[10] Rathod, R., Suryawanshi, N., &Memade, P. (2013). Evaluation of the properties of Red Mud Concrete. Proceedings of the Second International Conference on Emerging Trends in Engineering 2013 IOSR Journals, 31–34.
[11] Satyanarayana, P. P. V. V, Harshitha, A., & Priyanka, S. (2013). Utilization of Red Soil Bentonite Mixes As Clay Liner Materials, 4(5), 876–882.
[12] 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.
[13] Deshmukh, MP &Sarode, DD 2014, 'Bulk utilization of industrialwaste (bauxite residue) for production of red mud concrete, IOSRJournal of Mechanical and Civil Engineering, vol. 11, no. 6, pp. 1-3.
[14] Neeraja.D International Journal of Scientific & Engineering Research Volume4, Issue 2, February-2013
[15] Sonali K. Gadpalliwar and R. S. Deotale., "IOSR Journal of
Mechanical and Civil Engineering (IOSR-JMCE) Volume 11, Issue 2 Ver. II (Mar- Apr.2014)
[16] Vinayak A was are and Prof. M. V. Nagendra., International Journal of Advanced Engineering Technology, Vol.V/Issue II/April-June, 2014
[17] Rana, AY &Sa the, NA 2015, 'Analyzing the potential substitute of redmud in concrete adding lime and silica', International Journal of Emerging Technology and Advanced Engineering, vol. 5, no. 4,pp. 410-414.
[18] IS: 383, 1970, Indian Standard specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards, New Delhi. IS: 456, 2000, Indian Standard plain and reinforced concrete – code of practice, Bureau of Indian Standards, New Delhi, 100.
[19] IS: 8112, 2013, Indian Standard S\specification for Ordinary Portland Cement, 43 Grade Specification, Bureau of Indian Standards, New Delhi.
[20] IS: 9103, 1999, Indian Standard for concrete admixtures -specification, Bureau of Indian Standards, pp. 11.
[21] IS: 10262, 2009, Indian Standard concrete mix proportioning –guidelines, Bureau of Indian Standards, New Delhi, 14.
[22] IS: 516, 1959, 2004 Indian Standard methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi, 24 pp. Reaffirmed in.

