Experimental Study On Effect Of Use Of Red Mud Powder On Mechanical Properties Of Concrete

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Abstract- *A Red mud is an alkaline leaching waste that is obtained from bauxite during the Bayer process for alumina production and it is a "Hazardous" due to its high pH. Bauxite is a high volume solid waste, doesn't have any wide industrial applications. So the Red mud is used as an alternative material in the construction industries. The experiment outcomes show that how Mechanical properties (flexural strength, tensile strength, compressive strength, etc.) increase with increase red mud content. We are using here Grade M-25 concrete. Optimal percentage of the replacement of cement by weight is up to 15% with Red mud powder by this percentage replacement we can have upgraded Mechanical properties as equivalent to the conventional concrete.*

Keywords- Red Mud, pH, Alumina, Bauxite

I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age. Cement-based composites have long been used for civil structures such as highways, bridges and buildings. However, unexpected deterioration of reinforced or pre-stressed concrete structures has led to the improvement of durability of concrete [1]. Red mud particles will be added in cement-based composites by replacing with 10% to 30% for enhance concrete properties, particularly tensile strength, abrasion resistance and energy absorbing capacity. The presence of red mud particles would refrain the growth or propagation of internal cracks and helps to transfer load.

Aluminium metal is commercially produced from bauxite ore through two main process steps. In the first step alumina is obtained by the Bayers process and in the second step the alumina is electrolysed in a Hall-Heroult cell to yield aluminum metal. Production of alumina from bauxite by the Bayer's process is associated with the generation of red mud as the major waste material. Depending upon the quality of bauxite, the quantity of red mud generated varies from 55-65% of the bauxite processed. Bauxite ore mined globally amounts to 110 MTPA in 1994, 125 MTPA in 1998 and is expected to be around 145 MTPA at the moment. Based on the economic and as well as environment related issues,resues of red mud is of imperative importance. Red Mud or Bauxite Residue is a waste/by-product produced from the alumina industry. The worldwide annual production is 70 million tones. Its disposal remains an issue of great importance with environmental implications.

Replacing natural raw materials with wastes may offer a much sought after opportunity to mitigate today's waste management problems. Even if this is done in small amounts, high production rates will translate into significant consumption of waste materials and, for the industry willing to use them, the latter may constitute a cheap and renewable source of raw materials1[6]. In this context, upgrading industrial wastes to alternative raw materials is both technically and economically advantageous for a wide range of applications, including the fabrication of concretes and mortars3. In recent years, several studies have confirmed the potential of civil construction as a suitable recipient of various types of recycled wastes, which are now considered secondary raw materials. Red mud is the main waste generated in the production of aluminium and alumina by the Bayer process from bauxite ore. The world's production of bauxite in 2009 was 205 million tons, and the main producing countries were Australia, China, Brazil, Guinea, India and Jamaica. Ranking third in worldwide production in 2009, Brazil produced 26.6 million tons of bauxite. It also has the world's third largest bauxite ore reserves (around 3.5 billion tons), concentrated mainly in the northern part of the country. Roughly 0.3 – 1.0 tons of red mud waste are generated per ton of aluminium produced. Brazil has discarded about 10.6 million tons/year of caustic red mud in recent years and the worldwide generation of red mud exceeds 117 million tons/year7. Red mud is usually discharged as highly alkaline slurry (pH 10–13.5) with 15-40% solids, which is pumped away for suitable disposal.

Red mud as solid waste is generated in non-ferrous metal extraction industries like aluminum and copper. The red

mud at present is disposed in tailing ponds for settling, which more often than not finds its course into the rivers, especially during monsoon. However, red mud has recently been successfully tried and a plant has been set up in the country for making corrugated sheets. Demand for such sheet should be popularized and encouraged for use. This may replace asbestos which is imported and also banned in developed countries for its hazardous effect.

II. MATERIALS

CEMENT: Cement is a material that has cohesive and adhesive properties in the presence of water. Such cements are called hydraulic cements. These consist primarily of silicates and aluminates of lime obtained from limestone and clay.

AGGREGATES:Aggregate properties greatly influence the behavior of concrete, since they occupy about 80% of the total volume of concrete. The aggregate are classified as: (1) Fine aggregate& (2) Coarse aggregate. Fine aggregate are material passing through an IS sieve that is less than 4.75mm gauge beyond which they are known as coarse aggregate. Coarse aggregate form the main matrix of the concrete, whereas fine aggregate form the filler matrix between the courses aggregate. The most important function of the fine aggregate is to provide workability and uniformity in the mixture. The fine aggregate also helps the cement paste to hold the coarse aggregate particle in suspension.According to IS 383:1970 the fine aggregate is being classified in to four different zone, that is Zone-I, Zone-II, Zone-III, Zone-IV. Also in case of coarse aggregate maximum 20 mm coarse aggregate is suitable for concrete work. But where there is no restriction 40 mm or large size may be permitted. Sand was tested for the gradation purpose and found to be confirmed to zone-II as per IS: 383-1970 recommendations and checked physical properties also.

WATER:It is an important ingredient as it actively participates in the chemical reaction with cement to form cement gels having strength. The quantity and quality of the water added should be looked upon very carefully. For proper chemical action, the amount of water required is about 23% of the cement used, 15% of water is required to fill up gel pores and hence giving workability to the paste. Therefore 38% water is ideally required for complete chemical reaction.

RED MUD:Red mud is a waste product from the treatment of aluminium ore. The composition of red mud varies depending on the composition of the original ore, but the main constituents are oxides of different metals of which iron oxide, which gives the material its characteristic colour, is the most prevalent. Currently, no suitable use for red mud has been identified and for that reason it is stored in large dams adjacent to the treatment plants.

Table 2.2 Red mud properties

Ingredients	% In Red Mud
Fe_2O_3	38.3
Al_2O_3	21.6
SiO_2	11.4
CaO	1.47
Na_2O	6.87

III. LITTERATURE REVIEW

1. “Evaluation of the properties of red mud concrete”
Ramesh r. rathod , nagesh t.suryawanshi ,pravin d. memade.iosr journal of mechanical and civil engineering (iosr-jmce).

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 25%.By this replacement results got are nearly equal to the results of controlled concrete.
3. Concrete prepared by using red mud is suitable in ornamental works and gives aesthetically pleasant appearance.
4. Workability of concrete may get affected with increase of red mud but it can be improved by adding superplastcizers.
5. We use mixture of red mud & cement for nonstructural work. There is future scope for the use of red mud concrete in structural point of view.

2. “Use of red mud as addition for Portland cement mortars”

Daniel véras ribeiro, joão a. labrincha and márcio r. morelli. Journal of materials science and engineering, ISSN 1934-8959.

The aim of the present research work was to investigate the possibility of adding red mud, an alkaline leaching waste that is obtained from bauxite during the bayer process for alumina production, in the raw meal of Portland cement mortars. The red mud is classified as dangerous, according to nbr 10004/2004, and world while generation reached over 117 million tons/year. This huge production requires high consuming products to be used as incorporation

matrix and we studied the influence of red mud addition on the characteristics of cement mortars and concrete. in this paper the properties of Portland cement mortars incorporating high amounts of red mud was evaluated: pH variation, fresh (setting time, workability or normal consistency and water retention), and hardened state (mechanical strength, capillary water absorption, density and apparent porosity). Results seem promising for red mud additions up to 20 wt%.

3. Construction materials from industrial wastes-a review of current practices"- M. Ramesh ,k.s.karthic, t. Karthikeya and a. kumaravel. international journal of environmental research and development.

Nowadays, natural resources are depleting worldwide, while at the same time the generated wastes from the industries are increasing substantially. The aim of this paper is to describe the industrial and natural waste utilization in construction materials. According to their fineness and specific gravity the wastes are partially or fully replaced with the construction materials (cement, fine and coarse aggregates). The industrial wastes contain high pH and they are calculated under the different temperatures to improve its reactivity. Generally the wastes contain the pozzolonic properties due to its fineness and plasticity, so it increases the strength of the materials. The pozzolanic characteristics may partially replace the materials and known benefits on the durability of the products.

4."Self compacting concrete using red mud and used foundry sand"

kiran k. shetty, gopinatha nayak, rahul shetty k. ijret: international journal of research in engineering and technology.

The protection of the environment is a basic factor, which is directly connected with the survival of the human race. Parameters like environmental consciousness, protection of natural resources, sustainable development play an important role in modern requirements for construction. keeping this in mind, in this study the fresh and hardened properties of self compacting concrete (scc) using red mud as partial replacement for cementitious material along with used foundry sand as partial replacement for fine aggregate were evaluated. Cementitious material in the mixture was replaced with red mud at 1%, 2%, 3% and 4%. For each red mud replacement level, 10% of fine aggregate (regular sand) was replaced with used foundry sand (ufs).

5."Effect of the addition of red mud on the corrosion parameters of reinforced concrete"

D.V. Ribeiro, J.A. Labrincha, M.R. Morelli, Cement and Concrete Research 42 (2012) 124–133

The degree of saturation (humidity) of the concrete samples containing red mud appears to exert a considerable influence on the concrete's resistivity. The concrete specimens containing red mud presented higher resistivity in a humid environment, which is more favorable for corrosion. Evaluating the evolution of the corrosion process by corrosion potential tests is not possible; moreover, this technique only indicates the possibility of corrosion occurring, and should therefore be used as a complementary technique. The difference between the corrosion potential measures in wet and dry states is more pronounced in the reference samples (0%) which, due to their larger network of capillary pores, have a higher capacity to absorb solutions (capillary suction) and greater difficulty in losing this moisture (lower porosity) than samples containing red mud. An inversely proportional correlation was observed between the resistivity and the chloride ion penetration in concrete containing red mud in samples subjected to the same saturation condition.

SUMMARY OF LITTRATURE REVIEW PAPER: Considering all the above point it is interesting to say that the optimum utilization of Red Mud in concrete is 10 % as a partial replacement of cement by RM.

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, the attempt is made to check the effectiveness of red mud as a partial replacement of Portland cement.

Fly ash, red mud, silica fumes and copper slag are replaced with the construction materials according to the similar percentages and undergone the strength tests. The industrial wastes are turned into a valuable by products and reduce the environmental pollution.

Thus, all the wastes are having adequate strength and improved durability in their compressive strength and flexural strength in the concrete.

IV. RESULTS

- 7 day compressive strength maximum strength occurred when replacement by 15% RM with cement.
- 7 day compressive strength (cube) is 7% more than Conventional Concrete for Grade M35, 5% more than CC

for grade M50 and 5% decreasing than CC for grade M65.

- 28 day compressive strength maximum strength occurred when replacement by 15% RM with cement
- 28 day compressive strength (cube) is 10% more than Conventional Concrete for Grade M35, 7% more than CC for grade M50 and 7% decreasing than CC for grade M65.
- 28 day Split Tensile strength (cylinder) is slightly increasing by 5% at replacement by 15% RM with cement for Grade M35, while remain almost same for Grade M50 and Decreasing by 10% for Grade M65.
- 28 day Flexural Strength (beam) is remain same for Grade M35 for 15% RM replacement, 2% decreasing for Grade M50 and decreasing by 10% for Grade M65.
- From the result of slump test workability of RM concrete are gradually decreasing.

V. IS CODES

- IS 456- 2000 Plain and Reinforced Concrete Code of Practice
- IS: 10262 : 2009, Indian Standard Code of Concrete Mix Proportioning - Guidelines
- IS: 516 - 1959, , Indian Standard Code of Method of Tests for Strength of Concrete

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