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Study on Concrete by Replacing Cement with Red Mud, Fly Ash and Hydrated Lime : A Review Paper

Shishir Kumar Mishra, Reetesh Khare
Rabindranath Tagore University, Bhopal, Madhya Pradesh, India

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ABSTRACT

At global level, red mud (RM) production is rising as a result of the expansion of the aluminum industry. In overall, 0.8 to 1.5 tons of RM can be produced for every ton of alumina produced. Globally, 1.7 billion tons of RM are produced each year due to the aluminum industry's quick development. Due to the hydroxide (NaOH) injected throughout the production of aluminum, RM typically has a pH between 10.5 to 12.5.

In this study, we're looking at how red mud is used in concrete. Here, we're making concrete cube and beam samples with red mud added in the recommended weight percentage. and figuring out its tensile, flexural, and compressive strengths. Taking into account various concrete grade levels. The results of this study will support the physical property changes in concrete that were noticed after red mud was added.

Keywords : Red mud, Compressive strength test, Split tensile test, Non-destructive test, concrete, physical properties

I. INTRODUCTION

Red mud, produced by the Bayer cycle, is a mechanical waste procured throughout the production of aluminum. It is estimated that more than 66 million tons of this waste are produced annually worldwide. For every large load of alumina produced, approximately 1.6 large tons of red mud are delivered. The red mud is typically spread on land or released into the ocean, contaminating the water, air, and soil nearby, especially in areas where this industry is present. In light of this, actions should be taken to reuse this loss in an environmentally friendly manner. Significant efforts are made worldwide to address the executives red mud in use, stockpiling, and removal with knowledge of both financial implications as well as issues related to the natural environment.

The research into the creation of concrete members using a mixture of materials that primarily includes red mud and lime is presented in this project. This research study identifies yet another fruitful avenue for the efficient use of red mud. Concerned with the careless behavior of red mud, it frequently leads to the invention of concrete and solid development strategies by adding concrete. Because red mud, a product of the alumina industry, is a free resource, its use in the addition of concrete primarily demonstrates efficiency. The current study reviews research on the mechanical characteristics and strength of mud as well as cement, as well as the use

of red mud as a concrete replacement as a feature of an alternative rate.

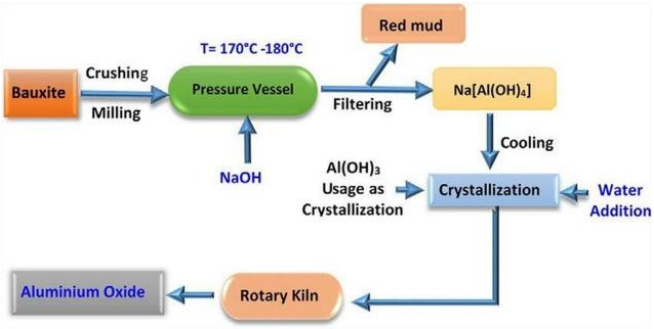

Figure 1.1 Bayer process of red mud and alumina production

The UPV methodologies were used for concrete structure checking, function, and monitoring. In order to guarantee the quality of concrete, a number of fundamental parameters are also measured and controlled using the UPV test. The understanding of these test results is the issue, and for that, appropriate knowledge of the influencing factors is required. [I.S. 13311-I:1992]. The test's fundamental tenet is that it measures how long it takes for an ultrasonic pulse to travel through the concrete under test; when the concrete is of great overall quality of density, uniformity, homogeneity, etc., a higher velocity is attained .Nondestructive tests were used by concrete scientists and engineers for decades to ascertain the characteristics of concrete. Since the 1930s, numerous vibrational methodologies for testing laboratory test specimens have been suggested. The first to conduct in-depth investigations utilizing vibrational techniques like the resonant frequency procedure were Powers, Obert, Hornibrook, as well as Thomson.

II. LITERATURE SURVEY

Kim Hyeok-Jung et al (2018)Across different tests on compressive strength, porosity, absorption, efflorescence region, alkali leaching content, as well as attributes of the efflorescence compound, the research study examined the efflorescence features in pavement actually contains red mud that can be impacted by strong alkaline. Irrespective of red-mud replacement ratio or type of binder, the compressive strength of pavement was determined to be higher than 15.0 MPa in all cases, which can offer adequate strength for bike and walking lanes.

Ramesh R. Rathod et al (2013) The objective of this study was to look into the viability of using red mud in place of Portland cement. The waste has a negative impact on the environment as a result of storage problems. Portland cement was substituted for up to 40% of the RM in this problem by weight of cement. Analyzing the red mud concrete's compressive and splitting tensile strength. This study investigates how red mud affects the characteristics of hardened concrete. The study found that as red mud content increases, concrete's compressive and tensile strengths decrease. The ideal substitute rate for cement in terms of weight is discovered to be 25%. Results from this replacement were almost on par with those from controlled concrete. Red mud can be used to create concrete that is appropriate for ornamental work and has a better appearance. Red mud content may affect concrete's operability, but super plasticizers can make it more workable.

Kedar S. Shinge et al (2015) The primary goal of the study was to recommend a percentage that could be used of red mud as well as rice husk ash in addition to cement to help the construction sector use less cement. In an incomplete mixture with the cement, red mud and rice husk ash have been used in the mortar. The compressive, tensile, as well as flexure behavior of the mortar samples was examined within the context of the mechanical strength of the cement.

P.Ashok and M.P. Suresh Kumar (2019) The purpose of the study paper was to explore the physico-chemical and mineralogical characterization of numerous industries wastes that could be used in the production of cement. Such industrial waste can be used as a raw material, blending component, or additive. As a result, the suitability of red mud for the

construction sector was examined. The replacement percentages of red mud and hydrated lime with cement in each series were 0%, 5%, 10%, 15%, and 20%, respectively. Five test groups were created. Hydrated lime was added to the red mud to create its pozzolanic properties. The best use of NRM is 15% as a partial substitute of cement by NRM, according to the results of testing of 5 blended cement samples (5% to 25% substitute of Cement by NRM) with an increase of 5%. The cost of M 30 grade NRM concrete (i.e., 15 percent replacement) was approximately 7.48 percent lesser than the price of traditional concrete, with a rise in 28-day compressive strength of up to 21.712 percent. The proportion economy risen as the concrete grade risen, but the percentage increase in compressive strength decreased at the very same period. The best percentage of Neutralized Red Mud to use in concrete as a partial replacement for cement was 15%. Red mud works well as a substitute for cement because it allows for a high level of waste product usage. Red mud did not affect the properties of cement; somewhat more, it enhanced cement performance by speeding up setting and increasing compressive strength.

Mahin Sha O B et al (2016) The physical characteristics of blended cement (Portland cement substituted by 0%, 5%, 10%, 15%, 20%, and 25%) red mud with constant water ratio concrete design mix of grade M25 were made and design mix was investigated for compressive strength in the research article.

The ideal replacements rate for cement in terms of weight is discovered to be 20%. The results obtained through this replacements are almost on par with those of ordinary concrete. The best percentage of Red mud to use in concrete by replacing for cement, according to the study's conclusions, was 20 percent. According to the study's findings, red mud can be a creative addition to cement - based materials, but skilled engineers must make wise choices.

N.K. Mhaisgawl et al (2021) The purpose of the article was to examine the possibility of using red mud in place of Portland cement in concrete, as well as to assess the strength of a material in compression and cracking tensile tests. Five experimental groups were formed up of 0 percent method for increasing. With every arrangement of concrete, add 40 percent red dirt and 5 percent hydrated lime.

Results showed that Red Mud, when used as a replacement for concrete in the range of 0%, 5%, 10%, 15%, and 20%, may easily mimic the properties of concrete. Red mud and cement should be combined for non-structural construction. From a structural perspective, red mud concrete has potential use in the future.

Supriya Kulkarni (2018) The goal of this study is to investigate the use of geo-polymerization of industrial effluents to create a green substitute for concrete mixture. In this work, the physico - mechanical characteristics of geopolymer concrete made from red mud, fly ash, and ground granule blast furnace slag (GGBFS) were investigated. Moisture content, compressive strength, flexural strength, and tensile splitting strength are among the characteristics that have been tested.

According to the findings of the experiments, geopolymerization of red mud, fly ash, and GGBFS can be utilized as a sustainable substitute for traditional concrete. Geopolymer concrete was found to have 89.4% the compressive strength of regular concrete. Geopolymer concrete was found to have a modulus of rupture that was 84.26 percent greater than that of regular concrete. Geopolymer concrete was discovered to have a modulus of elasticity that was 81.21 percent greater than that of regular concrete. Geopolymer concrete is shown to absorb more water than traditional concrete. According to the findings, geo-polymerization of industrial effluents can be a good and environmentally friendly substitute for traditional concrete, Hence.

Gowsalya. R and Bhagyalakshmi. A (2015) In the research project, it was evaluated whether red mud might partially substitute cement in concrete at various percentage (0, 5, 10, 15, 20, and 25%). Compressive strength and strength and flexural strength for cement concrete of M30 grade were used to study its impacts on the strength as well as other parameters of the concrete. The findings demonstrated that concrete's compression and tension strength are both decreased when more red soil is added. It has been determined that 20% is the appropriate replacement rate for cement in terms of weight. The outcomes of these substitutions are fairly comparable to those of controlled concrete. Red mud contents may make concrete more difficult to work with; however structural systems can improve its workability. The lighter weight of neutralizing red mud and its physical domain, which fill the cement's gaps and may raise the mix's density, may be the cause of the shorter first set times at 5 and 10 percent.

Nevin Koshy et al (2019) The research report investigated the manufacture of geopolymer paste material using two untreated inorganic compounds, Class-F fly ash and red mud. The red mud's high level of alkalinity was used to dissolve the silica inside the fly ash and red mud. The effects of the curing time, Si/Al, Na/Al, and liquid-to-solid (L/S) relations on the concrete strength of the finished products were evaluated. The mechanics, mineralogical, micro - structural, and pore features were also examined.

The distribution and production of different types of pores in the geo-polymeric matrices are affected by the rate of fly ash, where a high initial Si/Al ratio results in intermittent porosity in the final geo-polymeric matrix. The final product displayed 6.6 MPa at L/S of 0.35 for a 7-day curing time. Results revealed an inverse exponential distribution between the end products' unconfined compressive strength and the L/S ratio, which is comparable to the porous character traits. The minimum L/S ratio of 0.35 was discovered to be ideal for producing higher-strength fly ash-red mud-based alumino - silicate materials with less porosity.

Tejaswini. C and Anupama Natesh (2019) The goal of the study was to evaluate the aluminum red mud's strength properties in order to replace some of the cement in concrete. Red mud was substituted for cement in percentages ranging from 0% to 60%, with an internal of 10%, to create the specimens. A 5 percent addition of hydrated lime was made to the mixture to improve its binding abilities.

The test results of new properties that are more apt to be submerged in water increase as red dirt content rises. This increase in water use was anticipated since the red mud, which is somewhat lighter in weight, has better particles and more volume, both of which require more water to achieve the same consistency.. Red mud's properties are decreased when its content is increased in concrete, yet red mud may still be used in concrete for environmental sustainability. As the content of red mud increases, the carbonation rate decreases. According to these findings, red mud had a stronger corrosion resistance. Red mud is added to concrete to make it resistant to sulphate assault. The red mud replacement's ideal content was 20 percent. The best method to reduce environmental damage and the constructions industry's carbon footprint may be to utilize red dye in concrete.

Jaspal Singh (2019) The study on the use of red mud as a partial cement replacement and its impact on the mechanical properties and durability of mortars was summarized in the research paper. The study's conclusions claimed that red dirt produced during the manufacture of alumina is a concern on a global scale since it causes annoyance. India produces more than 4 million tons of red mud annually, compared to 120 million tons globally. Surface and ground water pollution can be greatly decreased by partially substituting red mud for cement. 2. Red mud can successfully be used as a partial cement replacement since its qualities are similar to those of cement. This reduces the need for cement manufacturing, which in

turn lowers CO2 emissions. When red mud is being used to partially replace cement, its compressive strength, tensile, and flexural strength all increase up to a point of 20% before decreasing. As a result, the findings indicated that 20% is the suggested maximum amount of red mud.

Kaliprasanna Sethy et al (2019) The research report concentrated on the practical application and acceptability of locally accessible red mud for cemented substitution in a variety of civil engineering constructions.

The ideal replacements rate for cement in terms of weight is discovered to be 10%. Results attained through this replacement were better than those of traditional concrete.

Rameez Ahmad Mantoo et al (2021) The purpose of the research article was to look at the subgrade use of red mud in highway maintenance. In accordance with Bureau of Indian Standards (BIS) regulations, all further attributes of the soil sample, including consistency limitations, relative density, particle distribution, compacted characteristic, and CBR value, have been determined experimentally. One of the crucial factors indicating the durability of the soils submarine base of the pavement surface is the CBR value. In Chittorgarh, red mud is frequently available. IRC 37 - 2012 offers recommendations for adaptable pavement construction. For roads with traffic of 450 heavy trucks each day or more, the soil constituting the sub - grade shall have a minimum CBR of 8%, according to the regulations. The soil sample's bearing ratios result from the California test is 37.03 percent, which is within the allowed range. Red mud can therefore be employed as a sub - grade in road building, it was determined.

Collin G. Joseph et al (2020) Research paper examined the present initiatives made to use red mud as a useful industrial by-product, which should lessen its detrimental environmental impact. The numerous unique uses of modified red mud as a coagulant, an absorbent for treating wastewater, as well as its use in catalytic reactions and in construction materials, are compiled and highlighted in this thorough review. Red mud's physical and chemical characteristics can be adjusted using a variety of treatment techniques, such as acidification, neutralizing, and thermal treatment. The literature study found that red mud modifications for the removal of many types of pollutants have demonstrated promising outcomes. Red mud needs to be further modified and altered, nevertheless, in order to use this industrial waste for numerous other industrial settings.

III.CONCLUSION

- The purpose of the current experiment experiments is to determine whether using red mud in cement concrete is practical.
- The compression strength of the red mud concrete are equal to those of concrete mixture with each percentage of replacement up to 20 percent.
- The experiment investigation revealed that both the mechanical properties and the tensile strength of concrete diminish when red mud content was increased (higher than 10%).
- An embankment landfill used for road building is a desirable choice with a high potential for large volumes reuse.

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