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A Comparative Analysis by Experimental Investigations on Concrete using Red-Mud Waste Material

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ABSTRACT

In recent years, there has been a rise in the production of red mud due to a wider increase in the aluminum industry. For each tonne of alumina, typically 0.8 to 1.5 tones of RM can be generated. The annual production of RM, which is produced globally is 1.7 billion tones because of the aluminum industry's explosive growth. RM typically has a pH between 10.5 and 12.5, caused by the hydroxide (NaOH) added during the production of aluminum. The primary objective of the research is based to conduct experimental analysis on replacing cement used in concrete with red mud in different proportions namely 5%, 10%, 15%, and 20%. As stated before, the objective stated the different applications for using red mud in concrete. The concrete cubes and beam were cured and cast where the red soil was added to the samples were analyzed for slump cone test, compressive strength and rebound hammer test. Considering a range of actual grade levels. The physical characteristics of concrete that altered after red mud was applied will be supported by the evidence from this experiment.

Keywords: Red Mud, Fresh Concrete Test, Compressive Strength Test, Split Tensile Test and Non Destructive Test.

I. INTRODUCTION

During the manufacturing of aluminum, the Bayer cycle produces red mud, which is a mechanical waste product. The annual global production of this trash is thought to be greater than 66 million tones. Red mud is supplied in quantities of around 1.6 huge tones for every large load of alumina produced. Especially in locations where this company is present, the red muck is frequently dispersed on land or dumped into the sea, contaminating the neighboring water, air, and soil. Actions should be taken in this regard to make use of this loss in an environmentally sustainable way. understanding of financial matters Numerous initiatives are being taken on a global scale to address the issue of red mud usage, storage, and disposal as well as related natural issues.

Red mud is currently produced in about the same mass proportion as metallurgical alumina and is dumped in either fixed or lockable fake impoundments that are reminiscent of landfills, posing major environmental issues. A goal of the work is to assess the aluminum red mud's strength properties as a concrete inside concrete replacement. by using red mud at rates ranging from 0% to 40%, with an average of 10%, in place of concrete. Along with all other improvements, hydrated lime's drawbacks were also mentioned. To create concrete with a range of raw material proportions, it is essential to research the compressive strength, split lastingness, and flexural strength properties of concrete. The focus of this study focuses on these three traits.

The making of concrete with its different membranes with different combinations of red mud and limestone is experienced in the project. This project identifies a new, promising direction for the effective usage of red mud. Concrete was designed as a superb development tool, and if you consider how red dirt acts carelessly, it frequently applies to concrete. Red mud, a byproduct of the alumina industry, is a free resource, hence adding it to concrete demonstrates efficiency. The current paper covers research on the mechanical properties and strength of cement and mud, as well as how employing red mud as an alternative to concrete affects such properties.

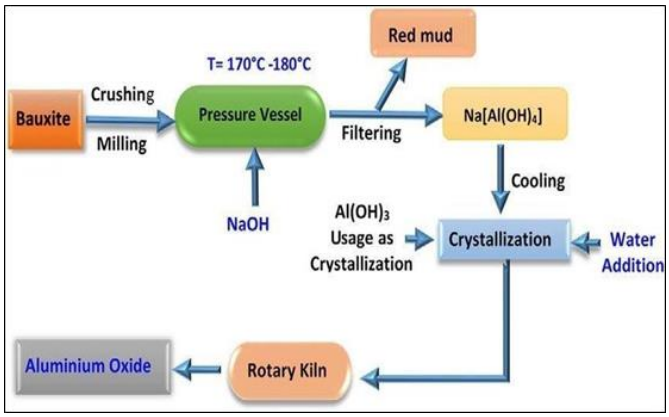


Fig 1 : Bayer process of red mud and alumina production.

Objectives of the Research

The production of red mud by the alumina industry is significant, which creates disposal issues due to red mud's environmental degradation and ecological unbalance. Red mud can be used to replace some of the cement in concrete, enhancing the material's physical and mechanical properties while also allowing for beneficial uses.

In this study, 5%, 10%, 15%, and 20% of the cement were swapped out for red mud. The following are the objectives of this inquiry.

- To determine the improvement in physical and mechanical characteristics of concrete using red mud.
- To determine the compressive and tensile strength of concrete samples preparedas cubes and beams.
- To determine the enhancement in concrete and carbon emission of the sample.
- To evaluate compressive strength using Non-destructive testing and destructivetesting.

II. LITERATURE REVIEW

N.K. Mhaisgawl et al (2021) To conclude the separating ace in basic waste material and to legitimize its blend being made industry, the creator here composed a close by assessment of enormous using red mud waste material and dissolvable base material. The author of this test diagram considered the different accessible test sizes. In this portion, the maker displays the various materials and examples of their conveyed compressive resources. Here, the maker's evaluation showed that the model with redbud has a ton of compressive strength, unwavering nature, and different climbs to its genuine properties.

Rameez Ahmad Mantoo et al (2021) To finish up the filtering expert in fundamental waste material and to legitimize its mix being made industry, the maker here created a nearby evaluation of massive utilizing red mud squander material and dissolvable base material. The writer of this test frame considered the different available test sizes. The manufacturer demonstrates

the various materials and times of their conveyed compressive resources in this section. In this instance, the manufacturer's evaluation revealed that the redbud-based model possesses a significant amount of compressive strength, enduring nature, and other climbs to its actual properties.

III. METHODOLOGY

Cement

The investigation was conducted using regular Portland cement (43 Grade) that complied with IS: 269-1976. To make sure the cement complies with the specifications of the IS, various tests were run on it. In accordance with IS: 4031-1968, the physical characteristics of the cement were ascertained and are shown in Table:1.

Table 1 Physical Properties of Cement

Physical Properties of 43 Grade Cement	
Characteristics	Values
Standard Consistency	43
Fineness of cement as retained on 90 micron sieve	3%
Initial Setting Time	30 mins
Specific Gravity	3.15
7 days compressive strength	30 Mpa

Table 2 Chemical Properties of Cement

Chemical Properties of Cement	
Components	**Weight**
Lime (CaO)	63%
Silica (SiO2)	22%
Alumina (A1203)	6%
Iron oxide (Fe203)	3%
Magnesium oxide (MgO)	2.50%
Sulphur trioxide & loss of ignition (SO3)	1.50%
Alkalies	0.50%

Fig 2 Cement

Coarse Aggregate

In this work, local coarse aggregate that conforms to Table 2 of IS 383 and has a maximum size of 20 mm down size is used. It is discovered that coarse aggregate has a specific gravity of 2.64. When tested for water absorption, coarse aggregate tested at 0.4%. listed in table 3.3 are the characteristics of coarse aggregate.

Table 3 Properties of Coarse Aggregate

Description	**Result**
Specific gravity	2.85
Fineness modulus	7.5
Water absorption	0.31%
Moisture content	Nil

Fine Aggregate

Fig 3 : Coarse Aggregate

Sand from a nearby river that passed through a 4.75mm screen in accordance with IS 383 provisions was used for the experimental programmer. Fine aggregate is found to have a specific gravity of 2.62. 1.0% of the fine aggregate tested for water

absorption. Table 3.4 provides information on the characteristics of fine aggregate.

Table 4 Properties of Fine Aggregate

Description	Result
Specific gravity	2.54
Fineness modulus	2.86
Water absorption	1.04%
Moisture content	2%
Zone	II

Fig 5 : Fine Aggregate

It is necessary to use fresh, clean water for casting and curing specimens. The majority of organic matter, silt, oil, sugar, chloride, and acidic chemicals are absent from the water, at least by Indian standards. During the hydration process, a cementitious material and water combine to form a cement paste. By glueing the aggregate together, a cement paste fills in the spaces and making the floor easily transportable.

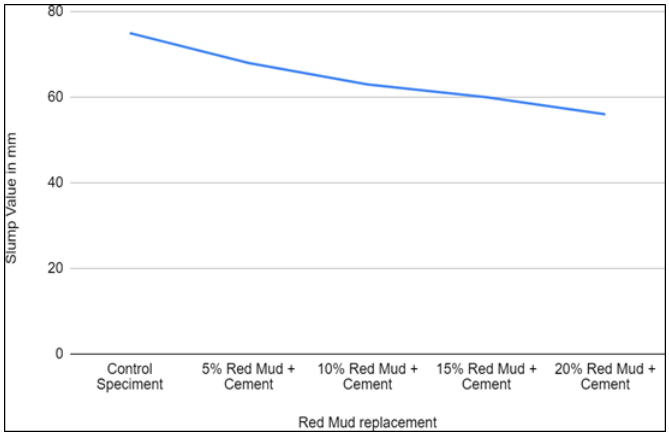
Red Mud

One of the main disposal problems for the aluminums industry is red mud, which is composed of solid and pollutants that contain metallic oxides. Its red colour comes from the iron that is present, which may make up as much as 60% of the red mud's volume. Silica, unbleached residual aluminums, and titanium oxide are the other main particles in addition to iron. Red mud is challenging to remove. Its Ph ranges from 10 to 13, making the mud, a byproduct of the Bayer process, a relatively basic chemical. Red mud's characteristics are determined by the type of bauxite ore utilized. With the help of readily accessible HCl, the pH was reduced from 10.6 to 8.6 to neutralize it. A uniform powder that fit through a 1.18 mm hole was used after the mud was sieved as well. Researchers have determined that red mud has a specific gravity of 2.93.

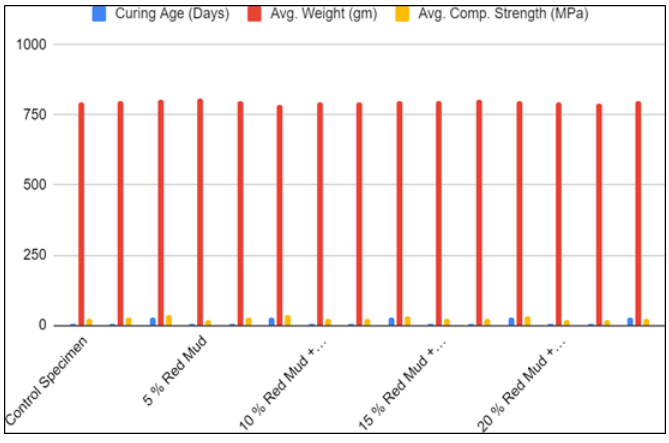
Fig 5. Red Mud

IV. ANALYSIS RESULT

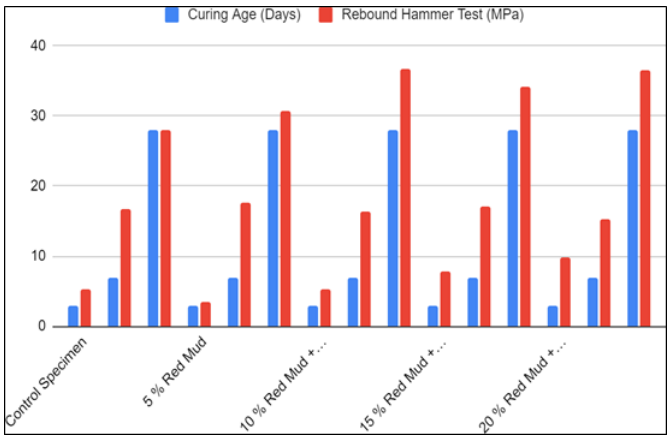
Slump Value



COMPRESSIVE STRENGTH:



REBOUND HAMMER TEST:



V. CONCLUSION

The purpose of the current experimental experiments is to determine if using red mud in cement concrete is practical. From the perspective of compressive, tensile, and flexural strength, it has been shown that a 5 to 10% substitution of red mud for cement is feasible without sacrificing compressive strength. However, from the perspective of compressive strength, tensile and flexural strength are somewhat diminished even for 5%, but appropriate results are seen at 10%,but after this progressive drop is noted.

The compressive strength values of the red mud concrete are equal to those of conventional concrete for each percentage substitution up to 20%.

The experimental investigation revealed that both the compressive strength and the tensile strength of concrete diminish when red mud content increases (higher than 10%). 10% is proven to be the ideal replacement rate for cement, measured in weight. Results from this substitution are almost on par with those of ordinary concrete. For non-structural operations, red mud and cement are mixed together.

Red mud concrete can be used for structural work with a mix of 5%, where compressive strength is high, but in other subsequent mixtures, we saw a decline in the sample's overall strength, demonstrating that red mud concrete may be used for non-structural work with a mix of more than 5%, such as infill masonry, blocks, etc.

From a structural perspective, red mud concrete has potential in the future. Red mud may be used to create concrete that is ideal for decorative work and has a nice look.

Future Scope

There is a vast scope to use red mud in huge quantities as fill and embankment material. The neutralization and stabilization of red mud in this study are limited to a single source for geotechnical characterization and laboratory investigations. Some of the verdicts are recognized for future studies.

1. In-situ studies and its laboratory validation of properties of red mud from different sources and different storage times.
2. Stabilization of neutralized red mud using other methods of stabilization and using other soils to be used as a clay liner, fill material etc.
3. Screening and identification of other microorganisms in red mud neutralization.
4. Effect of another biopolymer in red mud stabilization.

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