An Analysis of Red Mud Utilization in Concrete by Partial Replacement of Cement for enhancing the Compressive strength

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Abstract – Effective use of certain materials in civil engineering applications can reduce pollution and disposal challenges. Due to its high alkalinity, Red mud, a byproduct of turning bauxite into aluminum, accumulates and takes over more and more deforested land. An estimated 116 tons of red mud are produced annually worldwide with little opportunity of being used, presenting a serious risk of pollution and contamination. It is composed of silica oxides, iron, titanium, and aluminum, among other minor constituents. The primary basic materials used to produce cement, alumina and iron oxide, are absent from limestone but present in red mud. Red mud improves workability and compressive strength when used in place of some of the cement.

To evaluate the aluminum red mud's strength properties, laboratory experiments have been carried out. The acceptability of the red mud obtained for construction is the main focus of the project activity. For each series of M35 grade concrete, four test groups were created with cement partial replacement percentages of 0%, 5%, 10%, and 15%. Another intriguing avenue for the appropriate use of red mud is highlighted in this research.

***Key Words*: Red Mud, Partial Replacement, Workability, Compressive Strength.**

1. INTRODUCTION

Over the past 15 years, cement production has more than doubled globally as a result of urbanization and industrialization. It is projected that aluminum production would rise to over 50 million tons in 2015. Over 95% of the alumina produced globally is made using the Bayer process, which employs bauxite ore. Bayer's alumina production method generates red mud, a significant amount of dust-like, extremely alkaline bauxite residues. This by products in modern society, with an estimated global inventory of 3000 million tons at the end of 2010 and growing by about 120 million tons a year. The ore's source and the parameters of the mineralogical process dictate the amount of bauxite residue. Red mud yields 1–1.6 tons per ton of alumina.

The cost of disposing of red mud is one to two percent of the price of alumina. An experiment was carried out to partially replace cement with red mud in concrete at different percentages, taking into account the cementitious behavior of red mud. We also looked at how it affected the reinforcing of other concrete properties.

1.1 Importance of Utilizing the Red Mud in Concrete

Environmental improvement: Up to 320 million tonnes of carbon dioxide emissions might be avoided if industrial waste were to replace 30% of the cement used in construction projects globally. By using industrial waste in concrete techniques, the problem of not having enough space to dispose of the trash will be resolved, and contamination of the ground water may be controlled.

- Improving soil quality: Using sustainable, eco-friendly materials with the required structural strength should be our first priority as civil engineers. If we use red mud waste to make concrete, we will be able to solve the land storage issues and greatly improve the quality of the nearby soil.

- A decrease in the energy needed to produce regular Portland cement: Between 1.6 and 1.9 tons of raw materials are needed to make one tonne of cement. Clay, pozzolanic, and limestone components make up the majority of industrial waste. Examples of industrial waste that can be appropriately used to conserve natural resources and lower resource use are fly ash and red mud. It would also conserve energy and provide concrete structures the strength they need.
- Economic benefits: Cement production requires a large quantity of energy. Significant energy savings can be achieved by replacing cement.

2. Objectives of study:

- To identify various industrial wastes that can be successfully used in the production of cement.
- To determine the barriers to the usage of industrial waste.
- To develop recommendations to promote the use of industrial waste.
- To create some affordable, environmentally friendly alternatives to traditional building materials.
- Characterization of industrial wastes using physicochemical and mineralogical methods.
- To determine if industrial solid waste is suitable as a source material, blending material, or admixture.
- To look at the restrictions on using industrial waste.
- To offer suggestions to encourage the use of industrial waste.
- The demand for cement is currently far more than the total amount produced, and it is growing rapidly. With the aforementioned goals in mind, we aim to explore the suitability and application of dried red mud as a partial replacement for Portland cement in construction concrete.

2.1Properties of Red Mud

2.1.1Physical Properties of Red Mud:

- The fineness of red mud typically ranges between 1000 and 3000 cm2/gm.
- Since the PH ranges from 10.5 to 12, it is alkaline in nature.
- Red mud has a specific gravity of 2.62.

2.1.2Chemical Properties of Red Mud:

About 65% to 70% of the Red Mud is made up of solids, with the remainder being moisture. Below is a list of the Dry Red Mud's chemical components.

Table -1: Chemical composition of Red Mud

Components	Percentage (by weight)
Fe2O3	30-60%
Al2O3	10-20%
SiO2	10-20%
Na2O	2-10%
CaO	2-8%
TiO2	1.8-2%

3. Materials and Methodology

3.1 Cement

Cement is a binding material, which produce a cementing property by binding fine and coarse aggregate.

Table – 2: Physical Properties of OPC 53 Grade Cement.

Sr. No.	Characteristics	Values
1	Standard Consistency	53
2	Fineness of cement as retained on 90 micron sieve	3 %
3	Initial setting time	30 minute
4	Specific gravity	315
5	7 days compressive strength	37 MPA

3.2 Fine Aggregate

The fine aggregate has a specific gravity of 2.64 and most of the material may pass through a 4.75 mm IS sieve.

3.3 Coarse aggregate

The coarse aggregate comes from a local quarry. The coarse aggregate used in this study has a fineness modulus of 7.07 and a specific gravity of 2.84. It must measure greater than 12.5 mm and less than 20 mm.

3.4 Red Mud

Red mud, a byproduct of the Bayer process used to manufacture aluminum from bauxite, is transported from HINDALCO Belgaon to substitute cement.

3.5 Casting of Specimen

Test samples will be made as 150 x 150 x 150 mm cubes using the traditional molds. They employ cast

samples. The samples are remolded and kept in a water tank for seven to twenty-eight days of curing following a 24-hour casting process. A total of 24 specimens were cast in order to assess a number of properties, such as flexural and compressive strength. 24 cube samples measuring 150 mm X 150 mm X150 mm will be cast for different percentages of Red Mud replacement cement. Red mud replaces some of the cement in the concrete mixes at ratios of 0%, 5%, 10%, and 15%. Every cube will be cast in a single lift and consolidated using tamping rods. After the cubes have reached their final setting, the cube molds are taken out, and the cubes are allowed to cure in the water tank for seven to twenty-eight days. After the cubes have reached their final setting, the cube molds are taken out, and the cubes are allowed to cure in the water tank for seven to twenty-eight days.

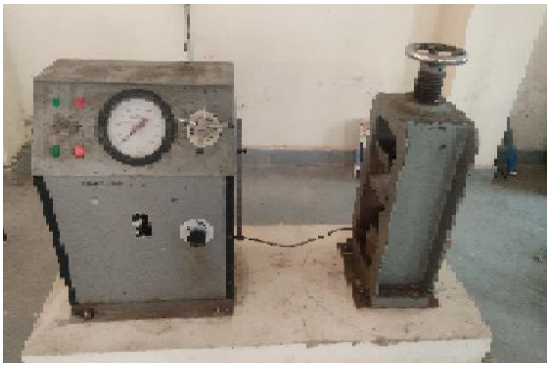

Fig 1. Compression Testing Machine

Table – 3: Number of Beams casted for 7 days and 28 days

% of Red Mud	Number of Beam Cast	
	7 Days	28 Days
0	3	3
5	3	3
10	3	3
15	3	3

3.6 Testing of Specimen

After a day, the specimens were removed from the mold and allowed to cure in water for either seven or twenty-eight days. After curing, the specimens were put through a compression test. The specimen's strength was tested after seven and twenty-eight days.

3.7 Workability

The workability of concrete of the M35 grade is assessed using a compaction factor test with a w/c ratio of 0.45 for the addition of different percentages of Red Mud.

Table -4: Slump values for different percentage of mix

% of Red Mud	Slump Value (mm)
0	94
5	88
10	76
15	70

3.8Experimental Methodology

3.8.1 Compressive Strength Test

The output of compressive strength after 28 and 7 days is recorded. The findings indicate that increasing the amount of Red Mud ash from 0% to 10% increases compressive strength; however, increasing the percentage of Red Mud ash further leads in a decrease in compressive strength. This suggests that up to 10% of cement can be substituted with Red Mud.

3.8.2 Experimental Result

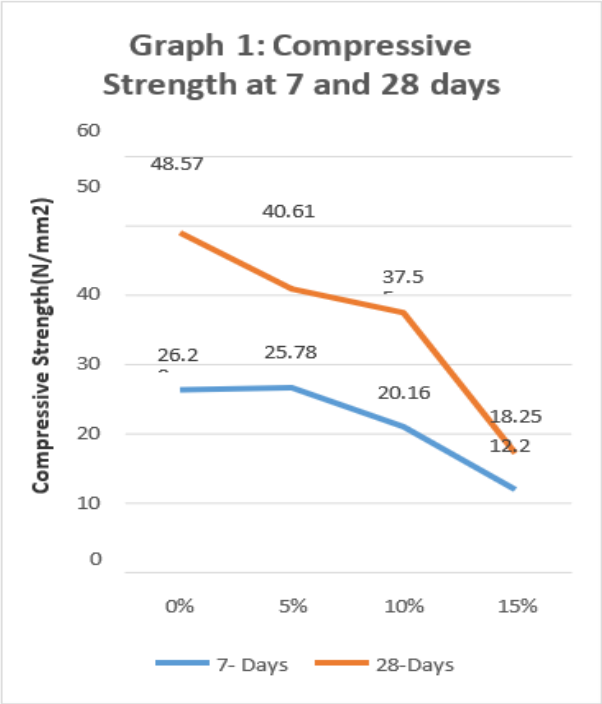

Table -5: Results of Flexural Strength

% of Red Mud	Compressive Strength	
	7 – Days	28 - Days
0	26.20	48.57
5	25.78	40.61
10	20.16	37.55
15	12.2	18.25

4. CONCLUSIONS

The experimental research may lead to the following conclusions:

- A decrease in slump indicates that red mud absorbs more water than cement, and an increase in red mud content reduces the compressive and tensile strengths of the concrete.
- Super plasticizers can help, but adding more red mud may make working with concrete more difficult.
- For a 10% replacement, M35 grade Red Mud Concrete is around 4% less expensive to produce than ordinary concrete. Therefore, we can conclude that red mud can be utilized as a cement substitute material with good results, allowing for the use of enormous waste products.
- Red mud and cement are used for non-structural tasks. One day, red mud concrete might be used for structural purposes. Lastly, we may conclude that red mud can be utilized as a long-term substitute for cement in the building sector as long as quality control is maintained.
- The Red Mud utilization in concrete by the partial replacement of cement may enhance the compressive strength of concrete.
- The Red Mud will mostly be come as an important material for different construction industry in order to improve the workability and compressive strength of concrete.
- But, Now a days, we can only partially use the red mud in the replacement of cement, because large amount replacement may create difficulty for concrete and its structure.

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