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AN EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE BY USING RED MUD AS PARTIAL REPLACEMENT OF CEMENT

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Abstract— **In present scenario the professional competition has been increased on the other hand environment concerns has also been increased that is why it has become essential to find alternative sustainable materials that can be broadly and continuously used. Industrial wastes can be a good substitute for conventional material, when utilized in a smart way. Red mud is a waste material generated by the Bayer Process used worldwide to form alumina from bauxite ore. The aim of the present research work is to explore the suitability of replacing the Portland cement by red mud. Because of storing issues, the waste has harmful effects on the environment .Red mud consists of alumina, iron oxides and other limestone properties which makes it one of the perfect and feasible ingredient for cement manufacture. On the other hand various steps have been taken for the disposal of red mud, utilizing it will automatically reduce storing and disposal issues up to an extent, and also bring a good way to produce economic concrete. Aim of our project is to investigate the strength characteristics of dry red mud under laboratory conditions Another main objective of this work is to study the effects of red mud on properties of concrete of M35 grade. The Red Mud is replaced by cement in the percentages by weight are 0%, 5%, 10% and 15%. The project work targets on the suitability and future scope of red mud in the construction.**

Key Words: **red mud, industrial waste, compressive.**

I. INTRODUCTION

Red mud is the solid waste residue of the digestion of bauxite ores with caustic soda in bayer's process of alumina (Al2O3) production. Around 35–40% of the bauxite ore goes into the waste as alkaline red mud slurry which consists of 15–40% solids and 0.8–1.5 tons of red mud is produced per ton of alumina production. Approximately annually 70 million tons of red mud is produced all over the world. More than 4 million tons of red mud waste is generated annually in India only. Its high alkalinity is main pollution hazard to water, land and air and huge costs are associated with its storage and residue since very large area required for its storage and disposal India is one of the major producers of aluminium.

Red mud is usually disposed in mud lakes in the form of slurry or heap in ponds as dry mud nearby around alumina plants or directly dumped into nearby sea by means of pipelines.

Red Mud contains fine particles, metal content, high alkalinity (pH 10–12.5) and trace because of this nature its disposal in large quantities of has caused serious environmental threats like soil contamination, groundwater pollution and sea water pollution. Moreover, when we store this it occupies large areas of land, and the storage of dry red mud can result in dust pollution which can cause serious respiratory and other health problem for the people living nearby the red mud storage ponds. Also the disposal of red mud turned out to be very costly, estimated about 2% of the alumina price. Over the years some great research work has been done all over the world to develop different economic and feasible ways for the utilization of red mud.

The huge quantity of red mud production require a safe disposal and it needs large areas of land for disposal and creates environmental problems. The remediation programs and its implementation costs approximately 120 millions per annum and it is growing at a rapid rate. For the betterment of waste management the idea of recycled waste material has became very popular and important. Most of the recent researches has been done on concrete which aims on the inclusion of industrial waste in concrete. This idea can be of a great benefit in industrial solid waste management. Thus the waste materials that meet the properties required for concrete ingredients can be used for concreting which will also lead to economic ways of concreting.

1.1 ADVANTAGES OF USING RED MUD IN CONCRETE

- **Betterment of Environment:** Replacing 30% of cement from construction practices worldwide by industrial waste can reduce carbon dioxide emissions upto 320 million tonnes. Replacing industrial waste in concreting practices will reduce the problem of lack of land for dumping the waste and also ground water contamination can be controlled.

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- **Improving soil quality**: As a civil engineer our main focus should be on using sustainable materials which will the required structural strength, and also be environment friendly. If we use red mud waste in manufacturing concrete the land storage issues will be resolved, and significant improvement in the nearby soil quality can be seen.
- **Saving in the Energy Requirements in the Production of Ordinary Portland cement:** approximately 1.62-1.9 tons raw material needed for production of single ton of cement. Most of the industrial waste consists of clay, limestone and pozzolanic materials. A proper usage of industrial waste such as red mud & fly ash would conserve the manipulation of resources and also saves natural resources. It would also save the energy consumption and provide required strength to the concrete structures.

Economic advantages: Cement production requires huge amount of energy. Replacement of cement can give significant energy savings. There is no energy requirement for reusing such waste. .

1.2 Objectives of study:

- To discover different industrial wastes which can be well utilized in cement manufacture.
- To identify the obstacles related to use of industrial waste.
- To draw guidelines to encourage utilization of industrial waste.
- To use of industrial wastes in place of conventional raw materials that will help in decreasing the environmental pollution and also in maintaining properly our natural resources.
- To develop some alternative economic construction materials which will also environment friendly.

Presently the demand of cement is very high than its total production and is rapidly increasing. By keeping the above objectives in mind our aim in this research work is to determine the suitability and utilization of dry red mud as a partial replacement of Portland cement in making concrete.

1.3 Properties of Red Mud

1.3.1. Physical Properties of Red Mud:

- Fineness of red mud varies between 1000- 3000cm2/gm usually.
- PH is between 10.5 to 12 hence alkaline in nature.
- Specific gravity of red mud is 2.62.

1.3.2. Chemical Properties of Red Mud:

Red Mud is containing about 65% to 70% Solids and remaining is moisture. The chemical composition of the Dry Red Mud is shown below.

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%

II. MATERIALS AND METHODOLOGY

2.1Cement

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	Intitial setting time	30 minute
4	Specific gravity	315
5	7 days compressive strength	37 MPA

2.2 Fine Aggregate

It is the aggregate most of which passes 4.75 mm IS sieve. Specific gravity of fine aggregate is found to be 2.64.

2.3 Coarse aggregate

The coarse aggregate is brought from a local quarry. The coarse aggregate with size less than 20mm and greater than 12.5 mm and having a specific gravity 2.84 fineness modulus of 7.07 is used in this study.

2.4 Red Mud

The Red mud used for the replacement of cement is brought from HINDALCO Belgaon, residue from manufacturing of aluminum from bauxite in Bayer's process.

2.5 Casting of Specimen

Test specimens of beam with 700mm x 150mm x 150mm will prepared using the standard moulds. The samples are cast. The samples are remoulded after 24hrs of casting and kept in a water tank for 7 and 28 days curing. A total of 24 specimens cast for testing the properties such flexural strength.

All specimen beams size 700mm × 150mm × 150mm will casted with optimum compressive strength for the specific mix in single lift and consolidated using tamping rods. After final setting of cubes, the cube moulds will be removed and cubes will kept in water tank for curing up to 7 and 28days.

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Fig. 1. Flextural 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

2.6 Testing of Specimen

After 24 hrs. the specimens were removed from mould and subjected to water curing for 7 days and 28 days. After curing, the specimens were tested for compression test. Strength of specimen were tested at 7 days and 28 days.

2.7 Workability

The workability of M35 grade of concrete is measured by compaction factor test with w/c ratio 0.45 for addition of different percentage of bagasse ash.

Table -4: Compaction Factor Test Results

Sr. No.	Description	0%	5%	10%	15%
1	Weight of Empty Cylinder (W1)	5.95	5.95	5.95	5.95
2	Wt. of Empty Cylinder + Free Fall Concrete (W2)	10.81	10.66	9.87	9.74
3	Wt. of Empty Cylinder + Hand Compacted Concrete (W3)	11.06	11.04	10.89	10.04
4	Wt. of partially Compacted Concrete (Wp = W2-W1)	4.86	4.71	3.92	3.79
5	Weight of Fully or Proper Compacted Concrete (Wf=W3-W1)	5.11	5.09	4.94	4.09
6	Compaction Factor = Wp/Wf	0.951076	0.925344	0.793522	0.92665

2.8 Experimental Methodology

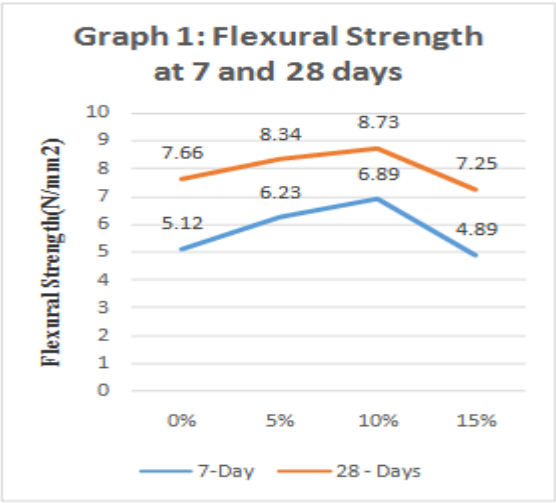
Flexural Strength Test

The result of compressive strength After 7 days and 28 days are recorded. Result indicate that as we increase percentage of Red Mud from 0% to 10% it's compressive strength increases after further increment in percentage of bagasse ash there is loss in compressive strength. That means we can replace up to 10% cement by Red Mud.

2.9 Experimental Result

Table -5: Results of Flexural Strength

% of Red Mud	Flextural Strength	
	7 – Days	28 - Days
0	5.12	7.66
5	6.23	8.34
10	6.89	8.73
15	4.89	7.25



III. CONCLUSIONS

Based on the experimental investigation the following conclusion are drawn

- From experimental work it was found that increase in red mud content decreases the compressive as well as tensile strength of concrete
- Red Mud absorbs more water as compare to cement, that can be seen by reduction in slump.
- Workability of concrete may get affected with increase of red mud but it can be improved by adding superplastcizers.
- The compressive Strength is decreased by increasing the replacement percentage in each set. Upto 10% replacement the compressive strength of cubes fulfills the acceptance criteria (as per IS 456 2000).
- The cost making of M 35 grade Red Mud Concrete (for 10 % Replacement) is around 4% less than the Conventional Concrete. So we can conclude that Red mud can be effectively used as replacement material for cement and replacement enables the large utilization of waste product.
- We use mixture of red mud & cement for non structural work. There is future scope for the use of red mud concrete in structural point of view.
- Finally we can conclude that red mud can be used as a sustainable alternative for cement in construction industry with quality supervision.

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