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An Investigation on Workability and Strength Characteristics of Red Mud Concrete

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Abstract:
Red mud waste material generated by the Bayer Process widely used to produce alumina Bauxite throughout the world. The aim of the present research work of investigates the possibility of replacing Portland cement by red mud. Because of storing issue, the waste negatively affects the environment. To solve this problem, Portland cement was replaced up to 40%of red mud by weight of cement. And evaluating its compressive and tensile and flexural of red mud concrete. This study examines the effect of red mud on the properties of hardened concrete.

Keyword: Red mud, Portland cement, Fine aggregate, Coarse aggregate, water, super plasticizer.

1. INTRODUCTION

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 materials. 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 mortars. 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.

2. LITERATURE REVIEW

2.1 Ramesh R. Rathod, NageshT.Suryawanshi ,Pravin D. Memade "Evaluation of the properties of Red Mud Concrete" Second International Conference on Emerging Trends in Engineering (SICETE) Dr.J.J.Magdum College of Engineering, Jaysingpur.

a. Red mud is a waste material generated by the Bayer Process widely used to produce alumina from bauxite throughout the world. The aim of the present research work was to investigate the possibility of replacing the Portland cement by red mud. Because of storing issues, the waste negatively affects the environment. To solve this problem, Portland cement was replaced up to 40 % RM by wt of cement And evaluating its compressive, splitting tensile, Flexural strength of red mud concrete. This study examines the effects of red mud on the properties of hardened concrete. The test results show that how its compressive strength & splitting tensile strength decreases with increase red mud content, it is concluded that Optimum percentage of the replacement of cement by weight is found to be 25%.By this percentage replacement we can have strength is equal to the strength of controlled concrete.
From experimental work it was found that increase in red mud content decreases the compressive as well as tensile strength of concrete. Optimum percentage of the replacement of cement by weight is found to be 25%.By this Concrete prepared by using red mud is suitable in ornamental works and gives aesthetically pleasant appearance.

2.2. P.Ashok, M.P.Sureshkumar, " Experimental Studies On Concrete Utilising Red Mud As A Partial Replacement Of Cement With Hydrated Lime" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 01-10 www.iosrjournals.org

The Bayer Process for the production of alumina from Bauxite ore is characterized by low energy efficiency and it results in the production of significant amounts of dust-like, high alkalinity bauxite residues known as red mud. Currently red mud is produced almost at equal mass ratio to metallurgical alumina and is disposed into sealed or unsealed artificial impoundments (landfills), leading to important environmental issues. It comprises of oxides of iron, titanium, aluminum and silica along with some other minor constituents. Presence of Alumina and Iron oxide in red mud compensates the deficiency of the same components in limestone which is the primary raw material for cement production. Presence of soda in the red mud which when used in clinker production neutralizes the sulfur content in the pet coke that is used for burning clinker enrooted cement production and adds to the cement's setting characteristics. Based on economics as well as environmental related issues, enormous efforts have been directed worldwide towards red mud management issues i.e. of utilization, storage and disposal. Different avenues of red mud utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. Experiments have been conducted under laboratory condition to assess the strength characteristics of the aluminum red mud. The project work focuses on the suitability

of red mud obtained for construction. Five test groups were constituted with the replacement percentages 0%, 5%, 10%, 15%, 20% of red mud and 5% of hydrated lime with cement in each series. To achieve Pozzolanic property of red mud, hydrated lime was added. This paper points out another promising direction for the proper utilization of red mud. From this experimental study following points can be drawn: After testing of 5 blended cement samples (5% to 25 % replacement of Cement by NRM) with an increment of 5 %, it can be said that the optimum use of NRM is 15% as a partial replacement of cement by NRM. The cost of M 30 grade NRM Concrete (i.e. 15 % Replacement) is around 7.48 % less than the Conventional Concrete, with an increase up to 21.712 % in the 28 days Compressive strength. The percentage economy is increased with the increase in the grade of concrete but at the same time there is a reduction in the percentage increase in the Compressive Strength Considering all the above point it is interesting to say that the optimum utilization of Neutralized Red Mud in concrete is 15 % as a partial replacement of cement by NRM. Red mud can be effectively used as replacement material for cement and replacement enables the large utilization of waste product. Red mud did not effect of the cement properties, rather improved the cement quality by way reducing the setting time & improved compressive strength. Used for road construction as an embankment landfill is an attractive option with a high potential for large volume reuse. Replacement of 20%OPC by red mud is thus possible. Red mud at 7000C lead to a pozzolanic material essentially reactive at early ages. In building material industry as a raw material in manufacture of building and pavement blocks and road surfacing. Dewatered (Ferro alumina) as a raw material in cement manufacture. In ceramic industry as an additive to make special ceramics. This thermal treatment changes the phase composition of the material, mainly by promoting the elimination of hydrated phases and improves its amorphous character; Physical parameters of red mud are affected by calcinations process: the surface area and the unitary mass decrease and the specific gravity increases; The results of pozzolanic activity by chemical and physical methods were very satisfactory and indicate the feasibility of red mud use as a pozzolan, in addition to Portland cement.

3. OBJECTIVES:

- Basically this paper is based on the dissertation work carried out to overcome the problems created due exhaustion and obsolescence of raw material required for manufacturing of conventional building material and also minimize the thrust of Indusial waste on the environment by utilizing the same in the Construction Industry. Some other objectives are;
- The use of industrial wastes in place of conventional raw materials will help to decrease the environmental pollution and also conserve our natural resources.
- The development of alternate low-cost and ecologically suitable building materials from agricultural and industrial wastes is an economic necessity.
- To identify various industrial wastes suitable for utilization in cement manufacture
- To examine the constraints related to utilization of industrial waste
- Current demand of cement is far in excess of production and is rapidly increasing.
- By keeping the above objectives in mind the aims of present work is to check the suitability and utilization of neutralized red mud as a partial replacement of Portland cement in concrete.

1. To study the compressive strength of concrete by using red mud concrete.
2. To study the split tensile strength of concrete by using red mud concrete.
3. To study the flexural strength of concrete by using red mud concrete.

4. MATERIALS

4.1 Cement: Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material.

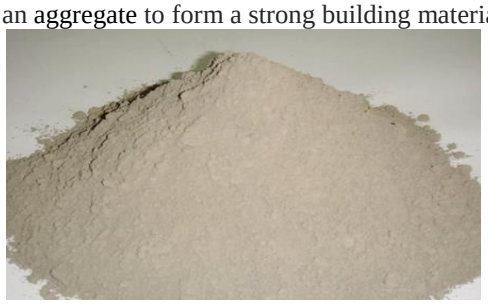


Figure.1. Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and many plasters. English masonry worker JosephAspdin patented Portland cement in 1824. It was named because of the similarity of its color to Portland limestone, quarried from the English Isle of Portland and used extensively in London architecture. It consists of a mixture of calcium silicates, aluminates and ferrites - compounds which combine calcium, silicon, aluminum and iron in forms which will react with water. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay and/or shale (a source of silicon, aluminum and iron) and grinding this product (called *clinker*) with a source of sulphate (most commonly gypsum).

4.2 Fine Aggregate:

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e. a soil containing more than 85% sand-sized particles by mass.

Figure.2. Fine aggregate

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica(silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish.

4.3 Coarse aggregate: Coarse aggregates are the crushed stone aggregate used in construction, including sand, gravel, crushed stone slag, recycled concrete .Aggregates are the most mined materials in materials such as concrete and asphalt concrete; the world. Aggregates are a component of composite the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and road side edge drains. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete.

Figure.3.Coarse aggregate

4.4 Red Mud:

The conventional method of disposal of red mud in ponds has often adverse environmental impacts as during monsoons, the waste may be carried by run-off to the surface water courses and as a result of leaching may cause contamination of ground water: Further disposal of large quantities of Red mud dumped, poses increasing problems of storage occupying a lot of space. Over the years, many attempts have been made to find a use for red mud, in this paper the attempt is made to check the effectiveness of red mud at 5% 10%, 15%, 20%, 25% over Portland cement by partial replacement of cement in concrete. Generally Fineness of red mud is varies in between 1000-3000 cm2/gm. We collected red mud from Hindalco Industries Limited, Belgaum, Karnataka (INDIA).In our study we have taken red mud passing through 300 micron I.S. Sieve.

- Its PH is varies in between 10.5 to 12.5 hence alkaline in nature.

CHEMICAL PROPERTIES OF RED MUD

Chemical properties of red mud are shown Table -1 it indicates that percentage of Cao is very less hence it has no cementation properties but when it react with water and cements it starts gaining cementations properties. Also Percentage of silica available, contributes to strength.

Figure.4.4. Red mud

4.5 Water:

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalis, vegetables or other organic impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement.

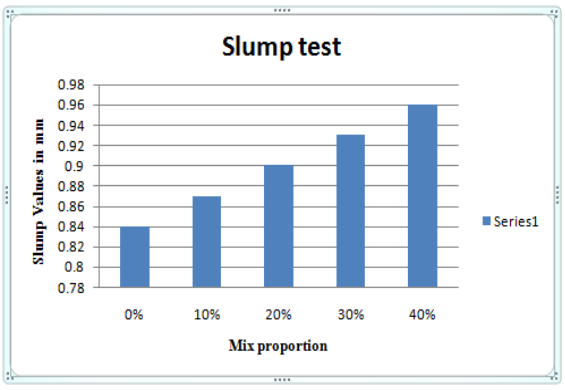
4.5. WORKABILITY TEST:

After the mixing, following workability tests are conducted on fresh concrete.

1. Slump cone test.
2. Compaction factor test.

Table .1. Slump values:

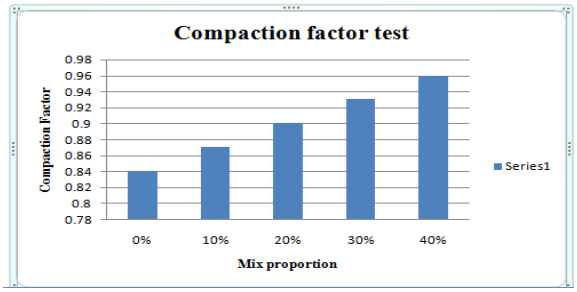
Percentage replacement of Cement by Red mud	Slump values
0%	25
10%	27
20%	29
30%	31
40%	33



Graph 4.5.1 Variation of slump

Table.2. Compaction factor:

Percentage replacement of Cement by Red mud	Compaction Factor
0%	0.84
10%	0.87
20%	0.90
30%	0.93
40%	0.96



Graph 4.5.2 Variation of Compaction values.

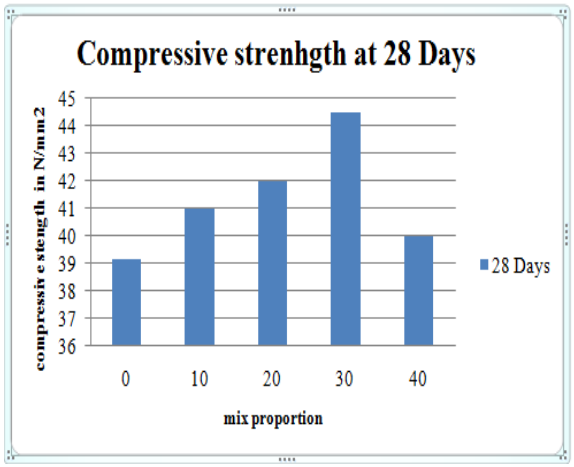
5. HARDENED PROPERTIES OF CONCRETE

5.1 Compressive strength test results: - For each concrete mix, the compressive strength is determined on three 150X150X150mm cubes at 28 Days of curing. Following Table 5.3 gives the compressive strength test results of control concrete and concrete made with different ratio of red mud.

Figure.4. show the photographic view of compressive strength test and failure of specimen.

Table.3.Compressive strength in N/mm^2

Mix proportion	Curing period (in days)	Failure load (kN)	compressive strength (N/mm^2)	Avg. compressive strength (N/mm^2)
M0	28	880	39.1	39.0
		885	39.33	
		875	38.8	
M10	28	920	40.8	41.0
		930	41.3	
		920	40.8	
M20	28	940	41.7	42.01
		950	42.2	
		948	42.13	
M30	28	990	44	44.5
		1000	44.4	
		1200	45.53	
M40	28	910	40.4	40.0
		890	39.5	
		900	40	



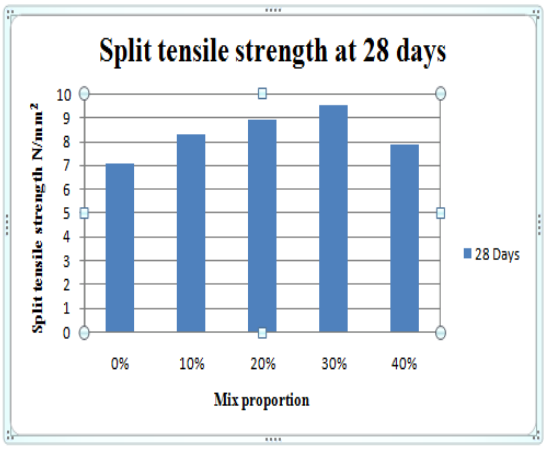
Graph no 5.1 variation of compressive strength in N/mm^2.

5.2 Split tensile test results: The test has been conducted after 28 days of curing. Split tensile test conducted on 150mm diameter and 300mm length cylinder as per IS: 5186-1999. Following test results gives the split tensile test results of control concrete and concrete made with different ratios of red mud.

Following Figure.5. show the photographic view of split tensile strength test and failure of specimen.

Table.4. Split tensile strength in N/mm^2

Mix proportion	Curing period (in days)	Failure load (kN)	Split tensile strength (N/mm^2)	Avg. Split tensile strength (N/mm^2)
M0	28	142.2	2.01	2.056
		147.1	2.08	
		147.1	2.08	
M10	28	166.7	2.36	2.25
		156.9	2.2	
		156.9	2.2	
M20	28	171.6	2.4	2.36
		171.6	2.4	
		166.7	2.36	
M30	28	181.4	2.56	2.42
		166.7	2.36	
		166.7	2.36	
M40	28	148.0	2.05	2.02
		145.0	2.01	
		145.0	2.01	



Graph no 5.2 variation of Split tensile strength in N/mm^2.

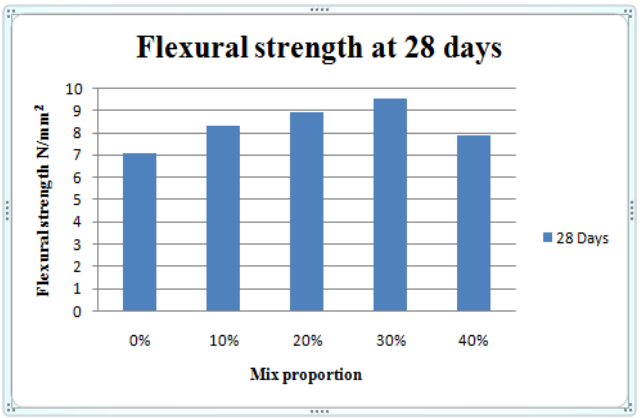
5.3 Flexural strength test:

- The following procedure is adopted to conduct the flexural strength test. Brush the beam clean. Turn the beam on its side, with respect to its position as molded, and place it in the breaking machine. The size of the beam specimen is 100 x 100 x 500 mm.

Figure.6. Flexural strength test.

Table.5. Flexural strength in N/mm^2

Mix Proportion	Curing period (in days)	Failure load (kN)	Flexural strength (N/mm^2)	Avg. Flexural strength (N/mm^2)
M0	28	13.73	6.8	7.03
		14.71	7.35	
		13.7	6.8	
M10	28	16.6	8.3	8.26
		14.7	8.24	
		13.7	8.24	
M20	28	17.6	8.83	8.9
		18.0	9.02	
		18.2	9.12	
M30	28	18.8	9.4	9.5
		19.03	9.5	
		19.2	9.6	
M40	28	16.0	7.85	7.85
		16.3	7.9	
		16.0	7.85	



Graph no 5.3 variation of Flexural strength in N/mm^2.

6. CONCLUSION

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 .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 super plasticizers.
5. 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.

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