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Experimental Study of Concrete Strength Properties Using Red Mud (bauxite residue) as a partial replacement of binder content for M25 grade of Concrete

Moh Juned[1], Mr. Anwar Ahmad[2]

[1]*M.Tech (Research Scholar), Department of Civil Engineering, Integral University Lucknow (UP), India*
[2]*Assistant Professor, Department of Civil Engineering, Integral University Lucknow (UP), India*

Abstract: - Now a day, various investigations and study has been presently going on to prepare an alternative or sustainable material for concreting. Now day's construction cost is very high with using conventional materials due to unavailability of natural materials. The problem can be solved by partial replacement of cement. The study is conducted to analyze the workability, compressive strength and split tensile strength of the concrete.Using partial replacement of Pozzolona Portland cement with red mud (Bauxite Residue). The thesis work focuses on the suitability of red mud obtained for construction. Five test groups will be constituted with the replacement percentages 0%, 5%, 10%, 15%, 20%, of red mud, for M-25 grade of concrete and is tested for optimum percentage.

Keywords:-Red mud, Cement, Workability, Compressive strength, Split tensile strength.

I. INTRODUCTION

Industrialization and urbanization are the two worldwide phenomena. Though these are the necessity of the society and are mostly inevitable, one has to look into their negative impacts on the global environment and social life. The major ill effect of these global processes is the production of large quantities of industrial wastes and the problems related with their safe management and disposal. Second problem is the scarcity of land, materials and resources for ongoing developmental activities, including infrastructure.
Red mud is a mixture of compounds originally present in the parent mineral, bauxite and of compounds formed during the Bayer process. Disposal of red mud is not easy. All over the world disposal of red mud is being done either on land or in the nearby sea/ocean. Red mud disposal presents a problem as it takes up land area which can neither be built on nor farmed, even when dry. Its high alkalinity is harmful to water, land and air of the surrounding area. Hence, bauxite disposal poses very serious and alarming environmental problems. The major effect of environmental problem, for the alumina industry it is the large amount of red mud (bauxite residue) is produce for the production of alumina. India is producing more than 4.71 million tons of red mud every year. Red mud is a solid waste to store the land areas and affect the natural soil. It is used in cement because red mud is a good binder material. The physical composition of red mud is the fineness 1000-3000 sq. cm/ gm and particle size <300 micron and PH is varying 10.5 to 12.5. And chemical composition is Iron oxide 40 to 45% and other aluminum oxide silica titanium dioxide calcium oxide sodium oxide.

II. OBJECTIVES

2.1 To find the appropriate percentage replacement of cement with red mud (bauxite residue).
2.2 To effectively utilize the waste material from alumina industries in concrete.
2.3 To study the effect of workability, compressive and split tensile strength and provide economical construction material and also provide safeguard to the environment by utilizing waste properly.

III. EXPERIMENTAL PROGRAM

3.1 Cement

IS: 1489 Part 1 1991 confirming of Portland Pozzolona cement (PPC) of 43 grade of cement is used.

Sr. No.	Properties	Observed Value
1	Normal Consistency	30 %
2	Initial Setting Time	31.5 minutes
3	Final Setting Time	613 minutes
4	Specific Gravity	3.15

3.2 Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75 mm sieve. For fine aggregate for sieve analysis the code use for IS 383:1970.

Sr. No.	Properties	Test Result
1	Grade Zone	II
2	Fineness Modulus	3.2
3	Specific Gravity	2.57
4	Silt Content	4.43%
5	Water Absorption	1.31%

3.3 **Coarse Aggregate**

Fractions from 20 mm to 4.75 mm are used as coarse aggregate. The coarse aggregate are obtained from a local quarry, conforming to IS 383:1970 is used.

Sr. No.	Properties	Test Result
1	Fineness Modulus	7.8
2	Specific Gravity	2.68
3	Water Absorption	0.42 %

3.4 **Red Mud**

The Bayer Process for the production of alumina from Bauxite ore is characterized by low energy efficiency and its results in the production of significant amount of dust like high alkalinity bauxite residues known as red mud.

Sr. No.	Properties	Test Result
1	Specific Gravity	2.98
2	Fineness	1000-3000 sq.cm/gm
3	pH	10.5-11.5
4	Particle Size	<300 Micron

3.5 **Mix design and proportion of M-25 grade of concrete.**

As per IS code 10262:2009, the mix design was done for M-25 grade mix and the amount the materials was estimated.

Sr. No.	Mix Design	M25
1	Cement	413.33 kg/m^3
2	Red mud	20.66 kg/m^3
3	Fine aggregate	644 kg/m^3
4	Coarse aggregate	1143.47 kg/m^3
5	Water	186 kg/m^3
6	W/C Ratio	0.45
7	Mix proportion	1:1.55:2.76

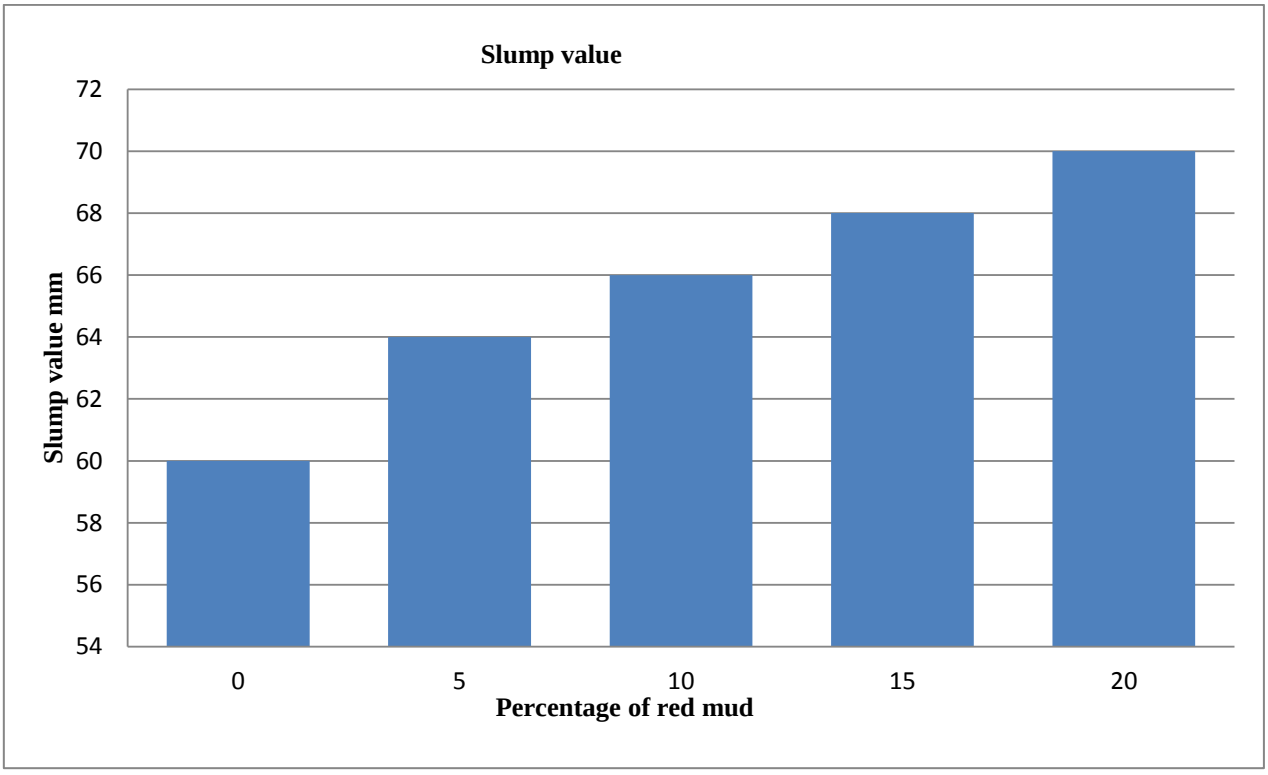
IV. **EXPERIMENTAL RESULT**

4.1 **Slump Test**

It is very essential for concrete to have good workability so that entrapped air can be easily removed by minimum effort of compaction. In field condition it is mostly observed that workability may vary from batch to batch due to the many reasons. The most common reasons being batching error of water, presence of surface moisture on aggregates and absorption of water by dry aggregates. Slump test for workability is the simplest test and is most often used at construction sites and must be carried out using the apparatus complying to IS: 7320-1974.

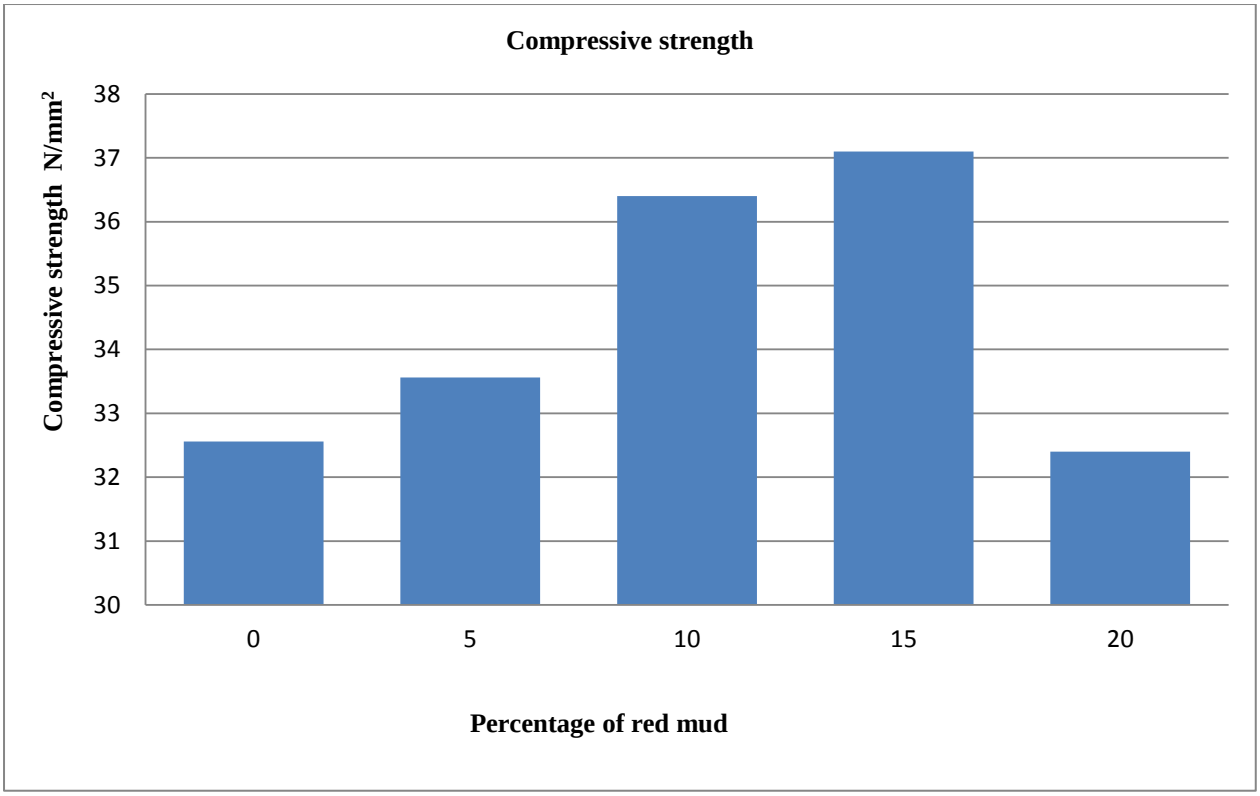
Sr. No.	Mix	Cement %	Red mud %	Coarse aggregate %	Fine aggregate %	Slump values mm
1	M1	100	0	100	100	60
2	M2	95	5	100	100	64
3	M3	90	10	100	100	66
4	M4	85	15	100	100	68
5	M5	80	20	100	100	70

Sr.No.	Mix	Cement %	Red mud %	Coarse aggregate %	Fine aggregate %	Compressive strength N/mm^2	Average
1	M1	100	0	100	100	32.5	32.56
						32.8	
						32.4	
2	M2	95	5	100	100	33.9	33.56
						33.6	
						33.2	
3	M3	90	10	100	100	36.7	36.4
						36.4	
						36.1	
4	M4	85	15	100	100	36.9	37.1
						37.1	
						37.3	
5	M5	80	20	100	100	32.6	32.4
						32.4	
						32.2	



4.2 **Compressive Strength**

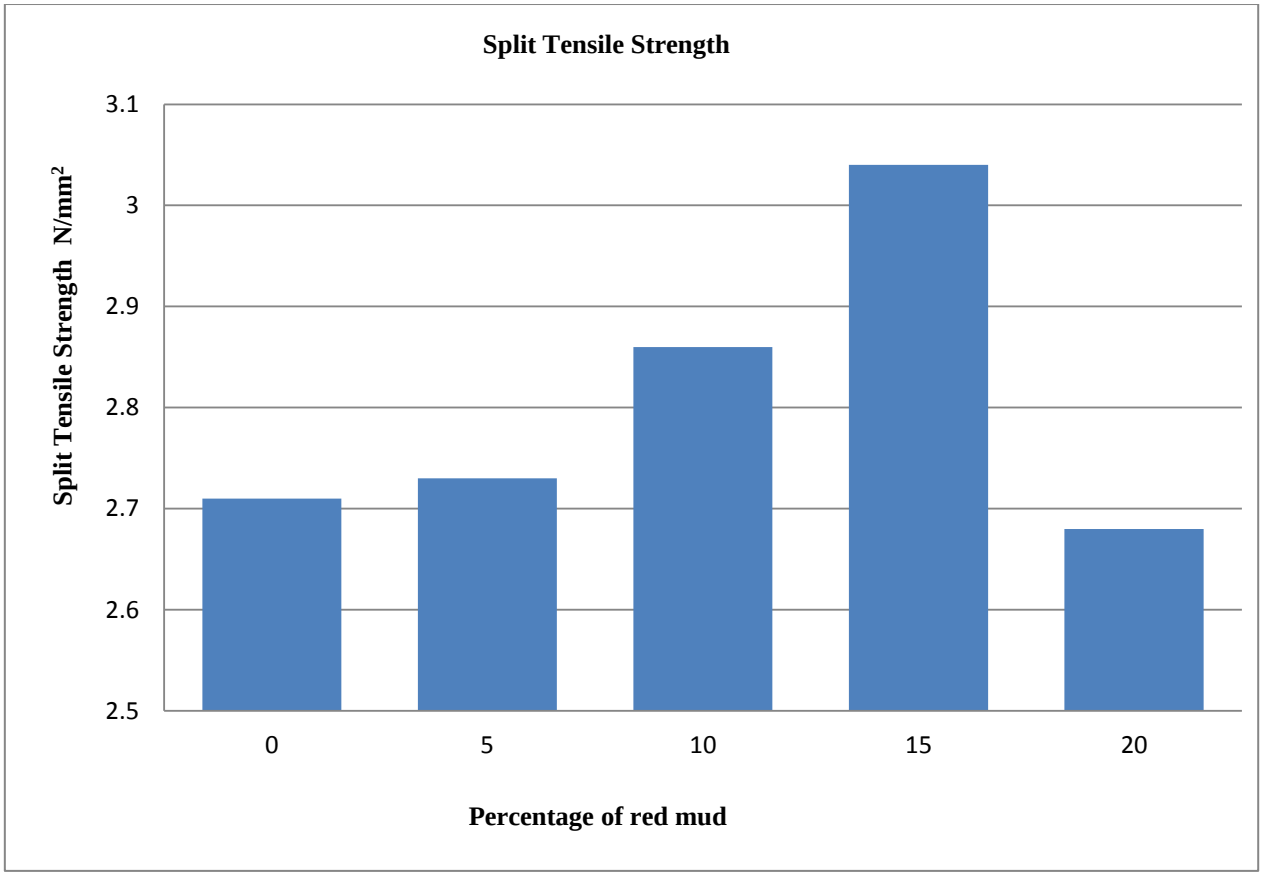
The compressive strength test is the most common test conducted on concrete, because it is the desirable characteristic properties of concrete are quantitatively related to its compressive strength. Compressive strength was determined by using Compression Testing Machine (CTM) of 3000 KN capacity. The compressive strength of concrete was testing using 150 mm x 150 mm x 150 mm cube specimens. The test was carried out by placing a specimen between the loading surface of a CTM and load was applied until the specimen fails. In this 15 concrete cubes moulds are filled with concrete at every costing or with different percentage.



4.3 **Split Tensile Strength**

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The cylinders are placed in the compression testing machine and load is applied as similar to the cube. The cylinder is placed horizontally and the test is performed. The load is increased until the specimen fails and the maximum load applied to test specimen during the test is recorded. In these 15 concrete cylinders moulds are filled with concrete at every casting or with different percentage.

Sr.No.	Mix	Cement %	Red mud %	Coarse aggregate %	Fine aggregate %	Tensile strength N/mm^2	Average
1	M1	100	0	100	100	3.17	2.71
						2.57	
						2.40	
2	M2	95	5	100	100	2.91	2.73
						2.68	
						2.62	
3	M3	90	10	100	100	2.52	2.86
						2.61	
						3.47	
4	M4	85	15	100	100	3.12	3.04
						2.92	
						3.09	
5	M5	80	20	100	100	2.88	2.68
						2.75	
						2.41	



V. CONCLUSION

From the experimental investigation conducted, the following conclusions are-

- Red mud is a desirable material for partial replacement of cement in concrete.
- The strength was gain up to 15% of replacement of cement with red mud in concrete.
- The experimental work, it was observed that increase in content of red mud decreases compressive strength and splitting tensile strength.
- The red mud used in concrete, helps in maintaining the environmental as well as economical balance.

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