Study of Concrete Strength Parameters using Red Mud as Partial Replacement of Cement with Hydrated Lime

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***Abstract*— Red mud is a modern waste material created during creation of alumina from bauxite by Bayer process. These industrial wastes hold some heavy aim of the paper is to investigate the chance of partially replacing Portland cement in concrete by red mud and evaluating its compressive and splitting tensile strength. Presence of Alumina and Iron oxide in red mud remunerates the lack of similar segments in limestone which is the essential crude material for concrete creation. Presence of soda in the red mud which when utilized in clinker creation kills the Sulphur content in the pet coke that is utilized for consuming clinker production concrete creation and adds to the concrete's setting attributes. In light of financial aspects just as natural related issues, colossal endeavours have been coordinated worldwide towards red mud the board issues i.e., of use, stockpiling and removal. The work centres around the reasonableness of red mud acquired for development. Five experimental groups were comprised with the substitution rates 0% To 40% of red mud and 5% of hydrated lime with concrete in every arrangement in concrete. To accomplish pozzolanic property of red mud, hydrated lime was added.**

***Index Terms*— Red mud, Hydrated Lime.**

I. INTRODUCTION

Red mud, created by the Bayer cycle, is a mechanical waste acquired during the creation of aluminium for every huge load of alumina created, roughly 1.6 huge a lot of red mud are delivered, and it is assessed that in more than 66 million plenty of this waste is yearly produced round the world. The red mud is usually released into marine or arranged into land dirtying the encircling water, air, and soil, particularly within the spaces where this industry is found. Along these lines, steps should be taken to reuse this loss in an eco-accommodating way. in sight of monetary aspects even as natural related issues, tremendous endeavours are done worldwide towards the executives red mud in use, stockpiling and removal. Presently red mud is made nearly at equivalent mass proportion to metallurgical alumina and is arranged into fixed or unlocked fake impoundments like landfills, prompting significant natural issues. within the task an exertion is formed to gauge the strength qualities of the aluminium red mud as fractional trade for concrete in concrete. By supplanting the red mud as substitution for concrete in rates from 0% to 40% at an enclosed of 10%. To upgrades the limiting properties hydrated lime of fifty is included alongside everything else this study is particularly focused on the compressive strength, split lastingness, flexural strength properties of concrete, which are the important parameters to be studied in concrete production of varied proportion of raw materials. This project presents the results of investigation on production of concrete members employing a mixture of materials which predominantly includes red mud and lime. This project points out another promising direction for the proper utilization of red mud. Brooding about the sloppy conduct of red mud, it tends to be applied to the innovation of concrete and solid development measures by adding a touch concrete. the use of red mud by adding concrete mostly demonstrates efficient on the grounds that red mud, an item from the alumina business, is accessible gratis. the present investigation rehashes research on the use of red mud as a substitute for concrete as a feature of an alternate rate and its impact on mechanical properties and strength in mud and cement. The manufacturing process of red mud is shown in fig below.

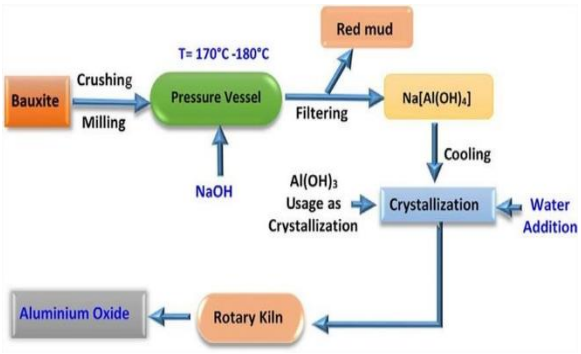

Fig 1: Bayer process of red mud and alumina production

II. COMPOSITION OF RED MUD

Red mud is made out of a combination of strong and metallic oxides. The red tone emerges from iron oxides, which can include up to 60% of the mass. The mud is exceptionally fundamental with a pH going from 10 to 13. In addition to iron, the other dominant components include silica, unbleached residual aluminum compounds, and titanium oxide. The fundamental constituents of the residue after the extraction of the aluminum segment are insoluble metallic oxides. The level of these oxides created by a specific alumina processing plant will rely upon the quality and nature of the bauxite mineral and the extraction conditions. The table 1.1.1 shows the creation ranges for basic compound constituents, however the qualities fluctuate broadly:

Table I Composition ranges for common chemical constituents.

Chemical	Percentage composition
Fe2O3	5–60%
Al2O3	5–30%
TiO2	0–15%
CaO	2–14%
SiO2	3–50%
Na2O	1–10%

Table II Mineralogically expressed the components present.

Chemical name	Chemical formula	Percentage composition
Sodalite	3Na2O·3Al2O3·6SiO2·Na2SO4	4–40%
Cancrinite	Na3·CaAl3·Si3·O12CO3	0–20%
Aluminous-goethite (aluminous iron oxide)	α-(Fe,Al)OOH	10–30%
Hematite (iron oxide)	Fe2O3	10–30%
Silica (crystalline & amorphous)	SiO2	5–20%
Tricalcium aluminate	3CaO·Al2O3·6H2O	2–20%
Boehmite	AlO(OH)	0–20%
Titanium dioxide	TiO2	0–10%
Perovskite	CaTiO3	0–15%
Muscovite	K2O·3Al2O3·6SiO2·2H2O	0–15%
Calcium carbonate	CaCO3	2–10%
Gibbsite	Al(OH)3	0–5%
Kaolinite	Al2O3·2SiO2·2H2O	0–5%

In general, the composition of the residue reflects that of the non-aluminum components, with the exception of a part of the silicon component: crystalline silica (quartz) will not react but a number of the silica present, often termed, reactive silica, will react under the extraction conditions and form sodium aluminum silicate also as other related compounds.

III. SCHEDULE FOR CASTING AND TESTING OF SPECIMEN FOR COMPRESSIVE AND TENSILE TEST FOR M40 GRADE OF CONCRETE WITH 5% OF HYDRATED LIME

Table III Specimen for compressive and tensile test for M40 Grade of concrete with 5% of hydrated lime.

Date of Casting	Red mud Percentage	0 %	10 %	20 %	30 %	40 %	Date of Casting
Compressive Strength Test (Number of Cubes Required)							
10 Feb 2021	7 Days	2	2	2	2	2	17 Feb 2021
12 Feb 2021	28 Days	2	2	2	2	2	12 Mar 2021
Split Tensile Test (Number of Cylinders)							
2 Mar 2021	7 Days	2	2	2	2	2	9 Mar 2021
3 Mar 2021	28 Days	2	2	2	2	2	31 Mar 2021

For M40 grade of trial mix concrete with 5% of hydrated lime to determine compressive strength 10 cube specimen of size 15x15x15 cm was casted. And to determine tensile strength 10 Cylinders of height 30 cm and of 15cm in diameter specimen was casted. After standard curing for 7days and 28 days it was tested under Compressive Testing Machine.

Table IV Compressive strength of concrete with 5% of hydrated lime.

Sr. No.	% of red med	7days compressive strength for M40 grade	28days compressive strength for M40 grade
1	0%	30	51
2	10%	32	54
3	20%	35	58
4	30%	24	48
5	40%	20	42

Table V Split Tensile Strength of concrete with hydrated lime.

Sr. No.	% red mud used	28days split tensile strength with 5% hydrated lime for M40 grade
1	0%	5.1
2	10%	5.4
3	20%	5.6
4	30%	4.8
5	40%	4.2

IV. LITERATURE REVIEW

Mr. Jaspal Singh (2019) Have studied the production of red mud in India is more than 4 million tons while in world, it is 120 million tons. By partially replacing cement with red mud, problem of surface and ground water pollution can be reduced to a great extent. Compressive strength, tensile strength and flexural strength of red mud mortar/concrete goes on increasing up to 20% of red mud used for the partial replacement of cement and then it is decreased. Hence, the paper states that the optimum percentage of red mud may be recommended as about 20%.

Mr. Sanket Bajirao Sutar (2018) Have observed that with the increase in neutralized red mud in the mix, the water required for standard consistency also decreases& this decrease water requirement shows almost linear relationship with standard consistency. Then after the Strengths are decreases as the percentage replacement of cement by NRM increases. The decrease in the strength is might be due to the finer size of Red Mud which increases the density of mix.

Mr. P. Syam Sai, et al (2017) Concluded that the compressive strength of concrete using 5% hydrated lime is more as compared with the concrete without hydrated lime. the share economy is increased with the rise within the grade of concrete but at an equivalent time there's a discount within the percentage increase within the Compressive Strength. Red mud is often effectively used as replacement material for cement and replacement enables the massive utilization of waste. Red mud didn't affect the properties of cement, rather improved the cement quality by way reducing the setting time & improved compressive strength.

Ms. K.Deepika, et al (2017) In this paper it had been observed that 20% replacement of the red mud for cement is possible from compressive strength, split tensile strength, flexural strength. Strength results of 20% of red mud replacement concrete shows two-fold strength increased within the M_{20} grade of concrete. The addition of admixture (complots WL) for M_{20} grade concrete increases the workability. Water absorption of concrete increases with increased percentage of red mud. Increased percentage of red mud increases the water absorption and reduces the strength of concrete.

Mr. Akarsh.N.K, et al (2017) From their experimental work it had been found that increase in red mud content decreases the compressive also as tensile strength of concrete. By this replacement results got are nearly adequate to the results of controlled concrete. Concrete prepared by using red mud is suitable in ornamental works and provides aesthetically pleasant appearance. Workability of concrete may get affected with increase of red mud but it is often improved by adding super plasticizers.

Mr. Dayalan. J, et al (2014) In their work they have concluded that the replacement of cement, sand and coarse aggregate with waste materials did not affect the properties of normal concrete mix drastically. At the same time, it gives fewer positive results when compared to the samples which have a single material being replaced. Also, the concrete can have benefits of light weight, economical, reduction in environmental pollution, good quality, high strength, durable and highly compact structure simultaneously.

Mr. Singh, et al (2014) They observed that UCS, CBR & compaction strength at addition of higher % of cement kiln dust showed a higher value up to 8% and further addition does not play vital role in increasing strength. The agglomeration of particles is very good as the % of cement kiln dust increased. Red mud replaced with 8% of cement kiln dust used well as a material in sub base and sub grade purpose.

A. B. Sawant, et al (2013) From their experimental work it's observed that decrease in initial setting time at 5% and 10% could also be thanks to the lightweight of neutralized red mud and finer particles of mud which fills the voids of the cement by which there could also be increase within the density of the combination. Beyond 10% of neutralized red mud cement initial setting time increases could also be thanks to reduction within the density of mix. The effect of replacement of cement by neutralized red mud has been studied on design mix concrete of grade M50. From economical point of view the traditional concrete costing around 13.7 yet one more than the costing of neutralized red mud concrete (15 % replacement) with the nominal decrease within the

compressive strength of two.97 instead of the particular 28 days compressive strength of M 50 grade concrete.

Mr. Mohan Kushwaha, et al (2013) Their study examines that the combination (Red Mud + SCC) should be used for the development activity it'll reduce the matter of environmental pollution at an equivalent time it reduces the value of the development and add it makes the concrete high working from the sturdiness point of view. during this paper the compressive strength of self-compacting concrete produced with the mixture of admixtures like (SP+VMA) goes on increasing up to twenty addition of red mud. the share increase in compressive strength at 2% addition of red mud is + 0.11 thus, it's observed that maximum compressive strength of self-compacting with the mixture of admixtures (SP+VMA). The compressive strength of concrete increases with the addition of Red Mud up to twenty then reduces and involves no increase at almost 4% addition. On addition of 4% could also be made to SCC with none loss to its compressive strength.

Mr. Pravin Nemade. (2013) This study examines the consequences 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's concluded that optimum percentage of the replacement of cement by weight is found to be 25%. By this percentage replacement we will have strength is adequate to the strength of controlled concrete.

V. CONCLUSION

Most research has focused on use of Red Mud as a partial replacement of cement and effective utilization of commercial waste i.e., Red Mud within the range 0%, 5%, 10%, 15%, 20%. It also shows that by such a replacement the characteristics of concrete has been achieved. Use mixture of red mud & cement for non-structural work. there's future scope for the utilization of red mud concrete in structural point of view.

REFERENCE

[1] Jaspal Singh "Effect of red mud as cement replacement on the properties of concrete" International Journal of Innovative Trends in Engineering (IJITE) Vol. 15 Issue 1 December 2019.

[2] Mr. Sanket Bajirao Sutar, December 2018 'Experimental Investigation of Effect of Neutralized Bauxite Waste (Neutralized Red Mud) on Concrete.' International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 12

[3] P. Syam Sai "Strength Properties of Concrete by Using Red Mud as a Replacement of Cement with Hydrated Lime" International Association of Engineering and Management Education (IAEME) Vol. 8, Issue 3, March 2017.

[4] K. Deepika "Experimental Investigation of Concrete by Red Mud as Replacement of Cement and Using Strengthening Admixture" The International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) Vol. 6, Issue 3, March 2017.

[5] Akarsh.N.K "An Investigation on Workability and Strength Characteristics of Red Mud Concrete" International Journal of Engineering Science and Computing (IJESC) Vol. 7, Issue No.5, May 2017.

[6] Dayalan. J "Effect of Waste Materials in Partial Replacement of Cement Fine Aggregate and Coarse Aggregate in Concrete" International Journal of Inventive Engineering and Sciences (IJIES) Vol.2, Issue-4, March 2014.

[7] Mr. Singh, et al "An experimental work on stabilizing red mud with cement kiln dust about 2, 4, 6, 8, 10 & 12%) and conducted the test. Dspace 2014.

[8] A. B. Sawant, et al "Utilization of Neutralized Red Mud (Industrial Waste) in Concrete" International Journal of Inventive Engineering and Sciences (IJIES) Vol.1 Issue 2, January 2013.

[9] Mr. Mohan Kushwaha, et al "Development of the Self Compacting Concrete by Industrial Waste (Red Mud)" International Journal of Engineering Research and Applications (IJERA) Vol. 3, Issue 4, Jul-Aug 2013.

[10] Mr. Pravin Nemade. "Evaluation of the properties of Red Mud Concrete." ResearchGate 2013.