A Study of Concrete Strength Parameters Using Red Mud as Partial Replacement of Cement with Fly Ash

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***Abstract* - Red mud could even be a waste generated by the Bayer process widely want to produce alumina from bauxite throughout the world. Ash could even be a by-product of coal-fired electric generating plants. Coal is put into a burning chamber for fast combustion and is blown. The aim of this paper is to research the likelihood of replacing the cement by Red Mud and ash. due to storing issues, the waste negatively affects the environment.to unravel this problem, cement is partially replaced with red mud and ash in small percentage, at an interval of 10% starting from 0 to 40% (20% red mud & 10% fly ash) by weight of cement. And evaluating its characteristic strength (i.e., workability, compressive strength & tensile strength) of red mud & ash concrete. This study examines the results of red mud on the properties of hardened concrete. Cement mortar is an intimate mixture of cement, sand and water. The strength of mortar depends on the proportion of sand and cement mixed. Cement mortar is applied to tie stones, brick-like masonry blocks and plaster slabs and walls. It is wont to give clean finishes to walls, concrete surfaces and joints for masonry. Red mud could even be a by-product during the manufacturing of the Aluminum. Aluminum is produced from the Bauxite ore. The two main processes for extraction of Aluminum from the Bauxite is; 1) Sinter Process, 2) Bayer Process. Among the two methods Bayer Process is that the foremost generally used method for manufacturing of Aluminum.**

***Index Terms* - Red Mud, Fly Ash, Bayer Process, Strength.**

1.INTRODUCTION

Red mud is hazardous waste generated within the Bayer process alumina production (Al_2O_3) from bauxite ore which contains high levels of residual alkalinity and toxic heavy metal. Therefore, red mud may be a hazardous waste of alumina industry. In Bayer process the sodium hydroxide is added to the powdered bauxite ore. During this process sodium aluminate solution and un-dissolved bauxite residue are formed. This bauxite residue contains silicon, iron and titanium and other materials. This Bauxite residue which is very caustic in nature is named as Red Mud. The quantity of red mud which generated within the alumina processing plant depends on the standard of crude Bauxite ore, could also be greater than the quantity of alumina 1-1.5 times. Alumina processing plants typically eliminate liquid red soil in reservoirs, which pose a serious environmental pollution threat to the lowland. A pozzolana is defined as a siliceous and aluminous material that in itself has little or no cemented value, but which maintains the presence of moisture during a microscopically divided form, chemically the properties of cement. Reacts chemically with lime at ordinary temperatures to form. Red mud means it is a waste biproduct generated by Bayer process during the assembly of alumina from the bauxite ore at a temperature about 150 to 230oc struggling with the presence of caustic soda. Hence red mud is additionally referred as Bayer process residue. About 1 to 2 plenty of residues of red mud that are of dry weight are made per ton of aluminum produced. Globally 75 million tons in per annum red mud is being created. Storage of red mud takes a huge area of useable land. Thanks to the presence of sodium hydroxide the pH value of red mud ranges from 10.5 to 13. So, it is highly alkaline in nature. Red mud contains heavy metals like aluminum, silica, calcium, iron and Titanium and alongside minor constituents like Na, Pb, Ba, Zn, Cr, Cu, Ni, Mn, K (Summers et al., 1996). So, it causes significant issue for soil contamination and spring water pollution and hence it cannot be useful for construction purposes and vegetation growth. The color of red mud is in red because iron compounds are present in it.

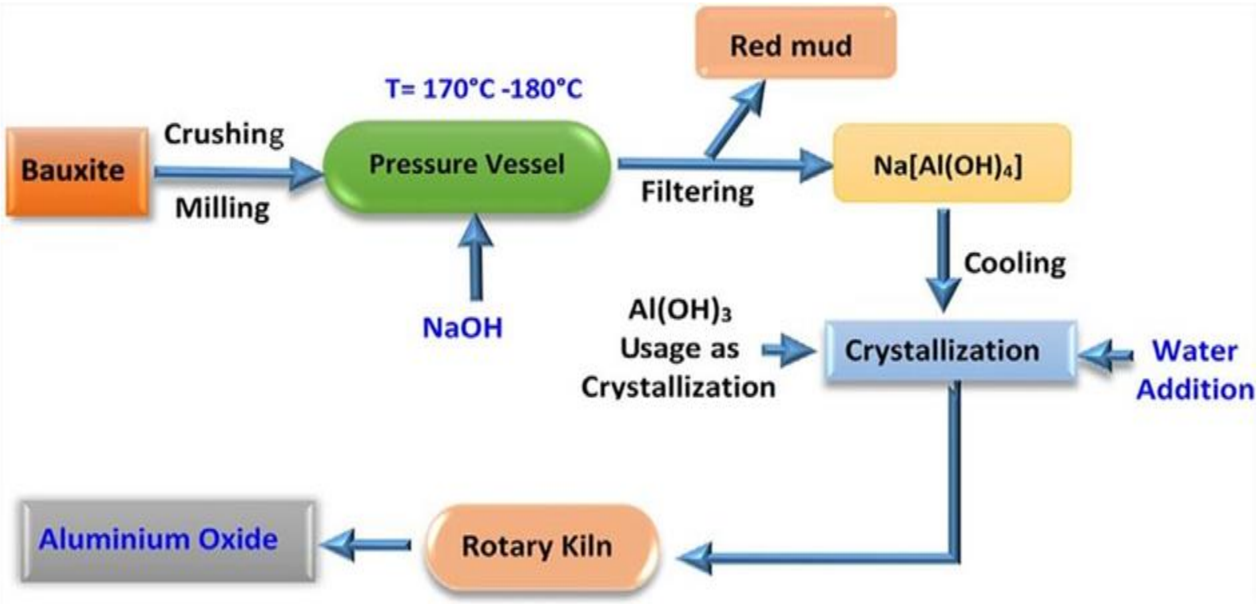

Fig 1: Bayer Process

Fly ash may be a by-product of coal-fired electric generating plants. Coal is put into a burning chamber for fast combustion and is blown. Heavier ash particle (lower ash or slag) falls under the rock of the burning chamber and thus lighter ash particles (fly ash) exit with exhaust gas, thus ash. Within the past, ash was generally released into the atmosphere, but pollution control standards now require that it's captured before release by fitting pollution control equipment. The ash is usually stored in coal power plants or kept in landfills. About 43% is recycled, often used to supply Portland cement or hydraulic plaster, and for the replacement or partial replacement of hydraulic cement within the assembly of concrete. Pozzolans confirm the installation of concrete and plaster and supply concrete with greater protection from wet conditions and chemical attack. Counting on the source and composition of the coal to be burned, ash components vary considerably, but all ash contains substantial amounts of silica (SiO_2) (both amorphous and crystalline), alumina (Al_2O_3) and quick time (CaO), Compounds in most mineral coal-bearing rock. Ash is that the most ordinarily used pozzolanic substance within the whole world. it had been first used extensively within the construction of the Hungry Horse Dam at Ashery within the US within an estimated amount of 30 percent by weight of cement.
After this it had been utilized in canyon and ferry dams etc. About 15 percent of the ash in India was utilized in the development of the Rihand Dam in situ of cement.

2. MATERIALS

1. Cement: A cement can also be a binder, a material used for construction to bind, harden and adhere other materials together. Cement is never used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregates produces mortar for masonry, or concrete with sand and gravel. Concrete is that the foremost generally used material alive and is behind only water because the planet's most-consumed resource. Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be described as non-hydraulic or hydraulic, respectively, depending on the strength of the cement within the presence of water.
2. Fine Aggregates: it is the mixture most of which passes 4.75 mm IS sieve and contains only such tons coarser as is permitted by specification.
3. Coarse Aggregates: it's the mixture most of which is retained on 4.75 mm IS sieve and contains only such a lot finer material as is permitted by specification.
4. Red Mud: A solid- waste generated at the Aluminum plants everywhere the planet. In Western countries; about 35 million plenty of red mud is produced yearly. Due to the complex physicochemical properties of red mud it's very challenging task for the designers to seek out the economical utilization and

safe disposal of red mud. Disposal of this waste was the primary major problem encountered by the alumina industry after the adoption of the Bayer process. m. during this paper the red mud is taken from Nehru Aluminum Research Development and elegance Centre Nagpur (INDIA). In this study the red mud taken skilled 300-micron I.S. Strainer. Its PH is in between of 10.5 to 12.5 subsequently basic in nature.

Physical Properties of Red mud:

Specific gravity of red mud ranges from 1.96 to 3.25 and fineness ranges from 1000 to 3000 cm2/gm. The density of red mud is 3.26 gm/cm3 and thus the particle size is 14.8 µm. Red mud is basic in nature.

Chemical Properties of Red mud:

The chemical properties of red mud like MgO ranges from 1.13 to 1.7, K2O ranges from 0.1 to 0.73 and MnO ranges from 0.078 to 0.1. The other chemical properties of red mud determined by different authors.

Fig 2: Red Mud

5. Fly ash: Fly ash may be a by-product of coal-fired electric generating plants. Coal is put into a burning chamber for fast combustion and is blown. Heavier ash particle (lower ash or slag) falls under the rock of the burning chamber and thus lighter ash particles (fly ash) exit with exhaust gas, thus ash. Within the past, ash was generally released into the atmosphere, but pollution control standards now require that it is captured before release by fitting pollution control equipment. The ash is usually stored in coal power plants or kept in landfills. About 43% is recycled, often used to supply Portland cement or hydraulic plaster, and for the replacement or partial replacement of hydraulic cement within the assembly of concrete. Pozzolans confirm the installation of concrete and plaster and supply concrete with greater protection from wet conditions and chemical attack.

Fig 3: Fly ash.

2. MIX PROPORTION FOR RED MIX CONCRETE

Mix design is obtained for M40 and M50 grade of concrete by using Indian standard code 10262:2019 guidelines.

GRADE OF CONCRETE	M50	
EXPOSURE CONDITION	SEVERE	
CEMENT	280.74	KG
RED MUD	120.32	KG
WATER	160.43	KG
CHEM. ADMIXTURE	20.05	KG
FINE AGG.	782.39	KG
C. AGG	1062.86	KG
TOTAL	2427	KG

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3. TEST AND INVESTIGATION ON RED MUD CONCRETE

Workability Test: Workability is an important property of the concrete in order that compaction is often through with minimum effort. The moisture within the fled condition may vary thanks to many factors like error in batching of water, surface moisture within the aggregate and absorption of water by the mixture. Slump test and compaction factor test is that the simple test to see the workability of the concrete on the location in laboratory using an apparatus called as slump cone and Compaction factor Apparatus.

Compressive Strength Test: the power of the concrete to resist the force which is trying to compress it's called as compressive strength. The specimens were cured for 7 and 28 days then test was performed thereon by using Compression Testing Machine (CTM) at the space temperature as per IS 516-1959.

Split Tensile Strength: An IS code method of determining the lastingness of the concrete indirectly is split lastingness. The cylindrical specimen was prepared was kept horizontally on the CTM machine and therefore the load will be applied until the specimen fails. The testing was done after 14 and 28 days after curing. The split lastingness of the specimen like the load at failure will calculate.

4. RESULT AND DISCUSSION

1. Workability Test: The slump value of the concrete made with red mud as replacement to the cement is quite that of the Control Mix. Because the replacement level of red mud increases the slump value also increase. The combination with fly ash shows more slump value as compared to the combination without fly ash. The rise within the slump value results in increase within the water requirement. The rise within the demand of water is thanks to the very fact that the red mud is lighter than the cement and it contains finer particle and it occupies more volume within the concrete.

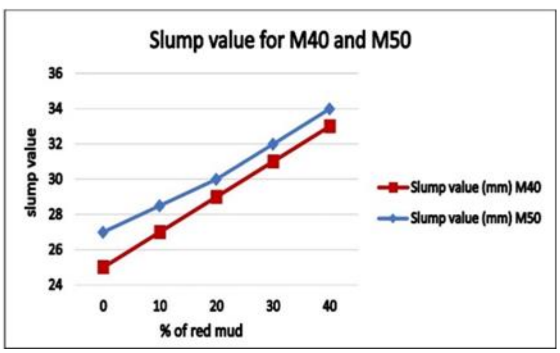

Fig 3.1: Slum Value for Workability

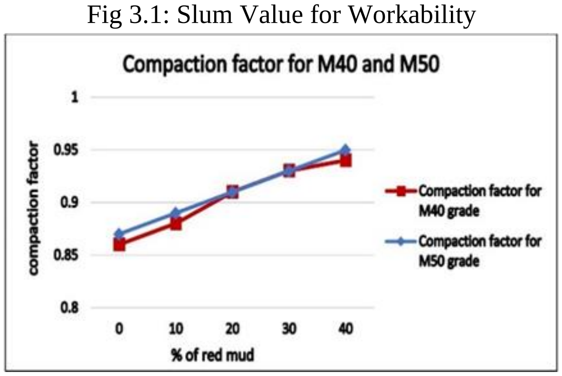

Fig 3.2: Compaction Factor Value for Workability

By the graphical representation shown in Fig 3.1 and Fig 3.2 it is observed that as increase in red med % increases in workability for both with and without fly ash after 30% of replacement with cement from slump cone test and Compaction Factor test.

2. Compressive Strength: The samples with red mud show comparable result as the control mix at 28 days of curing for 10% of replacement of red mud. It can be observed that for observed values as the replacement level of the red mud increases the compressive strength reduces for the specimen without fly ash. The strength reduction is around 27% as compared to the control mix. In this paper it's observed that concrete with lower red mud content shows the higher result and therefore the optimum percentage of replacement are often 20%.

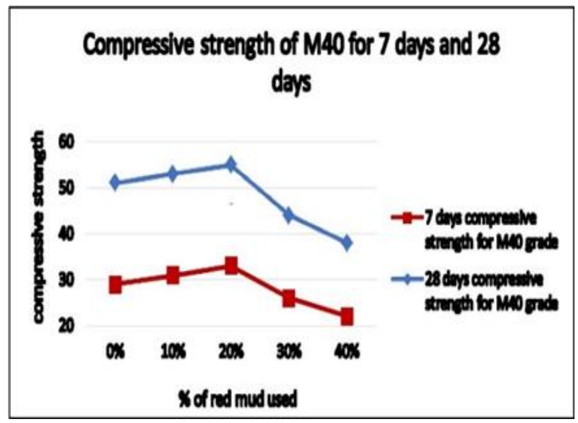

Fig 4.1: Compressive strength of M40 grade concrete without fly ash.

By the graphical representation shown in Fig: 4.1 it is observed that for M40 grade compressive strength increases by increasing in red mud percentage up to 20% in the condition without fly ash. After 20% of replacement with cement it goes on decreasing.

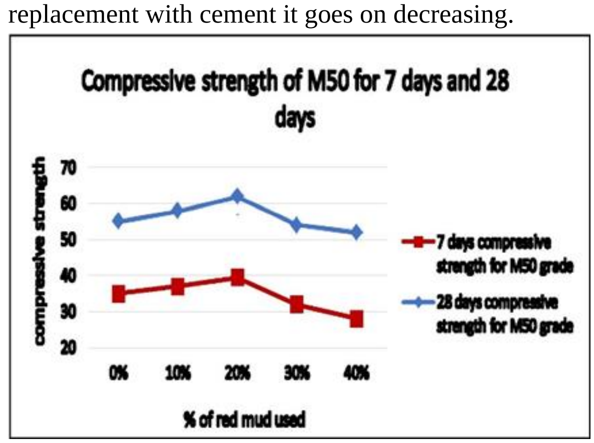

Fig 4.2: Compressive strength of M50 grade concrete without fly ash

By the graphical representation shown in Fig 4.2 for M50 grade compressive strength increases by increasing in red mud percentage up to 20% in the condition without fly ash. After 20% of replacement with cement it goes on decreasing.

3. Split Tensile Strength: In case of the sample without fly ash, as the percentage of red mud increases the split tensile strength reduces. The results are comparable red mud replacement up to twenty, thereafter the values are drastically reducing. So, the optimum dosage of red mud can be 20%. But in our case i.e. the sample without fly ash. We have to compromise a little with the split tensile strength when compared to the specimen with fly ash.

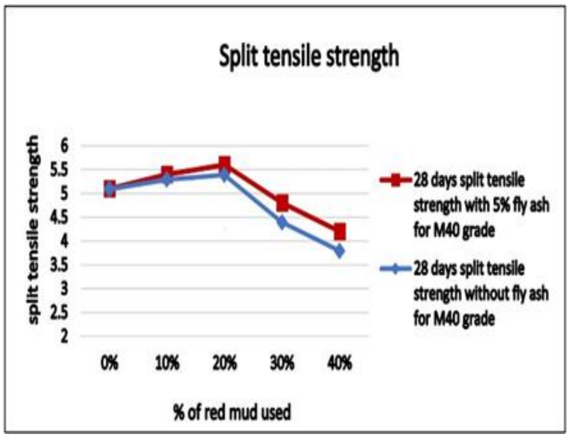

Fig 5.1: Split tensile strength of concrete for M40 grade

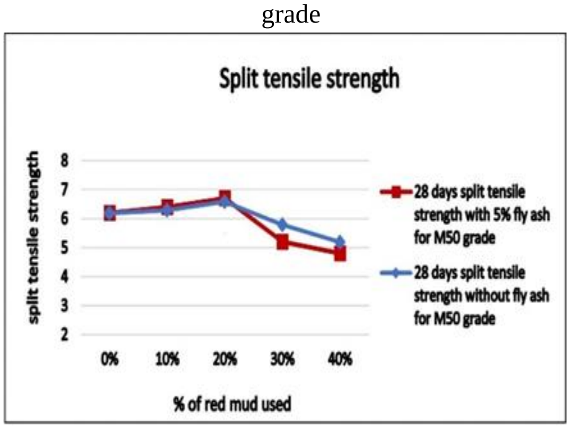

Fig 5.2: Split tensile strength of concrete for M50 grade

By the graphical representation shown in Fig 5.1 and 5.2 for M40 and M50 grade split tensile strength increases by increasing in red mud percentage up to 20% in the condition without fly ash after 20% of replacement with cement it goes on decreasing.

5. CONCLUSION

From this research the following are the conclusion of the work:

Optimum percentage of the replacement of cement by weight is found to be 25% by the replacement results got are nearly adequate to the results of controlled concrete. It's been noted that when the red mud and ash content is increased, the compressive strength and lastingness of the concrete decreases. In the present study, effort has been put to check the feasibility of red mud use in cement mortar. It is observed that replacement of the red mud for cement is possible from compressive, tensile and flexural strength point of view but need to be verify by exhausts experimental studies. Concrete prepared by using red mud is suitable in ornamental works and provides aesthetically pleasant appearance.

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