# A REVIEW PAPER ON EXPERIMENTAL STUDY OF CONCRETE STRENGTH PROPERTIES USING RED MUD (BAUXITE RESIDUE) AS A PARTIAL REPLACEMENT OF BINDER CONTENT FOR M30 GRADE OF CONCRETE.

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**Abstract:-**In the recent past, there has been a considerable attempt for improving the properties of concrete with respect to strength and durability, especially in aggressive environments. High performance concrete appears to be better choice for a strong and durable structure. A large amount of by-product or wastes such as fly-ash, red mud (bauxite residue) etc. are generated by alumina industries, which causes environmental as well as health problems due to dumping and disposal. Proper introduction of Red Mud in concrete improves both the mechanical and durability properties of the concrete. This paper present literature review on replacement of Cement by Red Mud which includes current and future trends of research.

**Keywords: Red mud, Fly ash, Cement, Workability, Compressive strength, Split tensile strength, Flexural strength.**

## INTRODUCTION

The production of caustic red mud makes the Bayer process an environmentally challenging process. Red mud, which derives its name from the color of the iron oxides in the substance, comprises up to 60 % of the bauxite material, depending on the ore. For each tone of alumina produced, up to two tones of red mud are generated. 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.

## LITERATURE REVIEW

**Rathod et al. (2012):** In this research the effect of red mud on the properties of M30 grade of hardened concrete was study. The Portland cement was replaced with red mud by weight of cement and find the compressive strength and splitting tensile strength. Result shows that the strength decreases with increase in red mud content. The maximum percentage of the replacement for cement by weight with red mud was 25%, the strength is equal to the strength of control mix concrete. [1]

**Sawant and Kumthekar (2013):** In this paper the effect of replacement of cement by neutralized red mud on design mix of M50 grade of concrete was observe. The water-cement ratio was constant (0.36). The replacement of cement with neutralized red mud for different percentage is use. The result show that to increased the neutralized red mud then decrease the strength at 7 days as compared to pure cement concrete in 7 days. The average compressive strength decrease with increased the neutralized red mud. [2]

**Yao et al. (2013):** It was study the possibility of incorporating red mud and coal industry byproducts in the raw material for producing cementitious material. Results show that the designed red mud-coal industry byproducts based cementitious material

was higher strength gain in the middle to late curing age (47.5 MPa in 180 days and 48.7 MPa in 360 days) than the control mix. It was also demonstrated that, this cementitious material had good stabilization ability to bind the heavy metal in the red mud as raw material. [3]

**Yogananda et al. (1988):** examined the pozzolanic properties of rice husk ash (RHA), burnt clay (BC), and red mud (RM). It was observed from the compressive strength. They are satisfying the requirement for secondary construction applications like masonry and plastering. Lime-RHA mortars with RHA containing a mixture of amorphous and crystalline silica lead to higher long term strengths. The RHA samples containing amorphous silica have lead to higher 28 days strengths. However, it was decrease in strength after 28 days. Results of lime- RHA mortar with RHA containing mostly crystalline silica have shown that prolonged grinding of crystalline RHA enhances its lime reactivity. The long term strength gain over 28 days is much higher than in case of other RHA samples. [4]

**Kolesnikova et al. (1998):** It represented that the introduction of up to 5% of red mud and iron oxide pigment up to 8% makes it possible to improve the colour of the brick, and increase strength and decreases water absorption. Moreover, pigment additives can be used for decorative pinkish- lilac coloring of the surface layer of ferroconcrete wall panels. [5]

**Prasad (1999):** It was study to stabilize the red mud blocks by Banaras Hindu University (BHU). From a mixture of red mud, fly ash, lime grit and ordinary port land cement, blocks of high strength 60 $kg/cm^2$ were produced after sun drying (curing). CBRI, Roorkee has developed stabilized blocks whose strength is between that of grades II/III class bricks. Red mud + clay and Red mud + fly ash bricks of high strength comparing to grade I bricks have been developed. BHU has prepared low density/hollow bricks and blocks of red mud with low density 1.1-1.2 $g/cm^3$. These hollow/foamed bricks have varying crushing strength of 50-260 $kg/cm^2$, used a mixture of red mud, fly ash and additive with firing at 1000 °C producing bricks with crushing strength of 130-160 $kg/cm^2$ and 14% water absorption capacity. Central Glass Ceramic Research Institute (CGCRI), Jadhavpur has also prepared hollow bricks using red mud and a proprietary foaming agent. Red mud + clay and Red mud + fly ash bricks of high strength comparing to grade I bricks were developed. [6]

**Akarsh N.K et al.(2017):** To study the Portland cement was replaced up to 40% of red mud by weight of cement and finding the compressive tensile and flexural strength of the red mud in concrete. Result shows that after 28 days the compressive strength 44.5$N/mm^2$ is maximum for M30 grade of concrete and tensile strength is 2.42$N/mm^2$, flexural strength is 9.5$N/mm^2$. For M40 grade of concrete all the strength was decreased and workability of concrete is decrease to increase the red mud. It can improve to add the super plasticizers. [7] **Senff et al. (2010):** This paper was represent the effect of red mud addition on the rheological behavior and on hardened state characteristics of cement mortars was study. Red mud decreases the workability increases. The torque causes lower impact than water variation. Mortar with similar spread on the table show different behavior along the rheology test. Values of spread table follow a quadratic model and red mud exhibited an interactive effect with water. Red mud did not change the hydration process, but above 20% the maximum temperature decreases. The reduction of compressive strength is not constant and depends on the water added. Its variation also follows quadratic model. [8]

**Liu et al. (2011):** To study the evaluation of the cementitious activity of calcined red mud for testing the compressive strength of blended cement mortars. The results show that the red mud calcined at 600 °C has good cementitious activity due to the formation of poorly-crystallized $Ca_2Si0_4$. The poorly-crystallized $Ca_2Si0_4$ is a metastable phase which transformed into highly-crystallized $Ca_2Si0_4$ with the increase of calcinations temperature from 700°C moving to 900 °C. The metastable phase to contribute good cementitious activity of red mud. [9]

**Da-wei et al. (2012):** This paper was focus of the ultra light weight sludge-red mud ceramic was prepared by red mud, clay and dried sewage sludge was study. For thermal analysis the red mud is high hydroscopic and good water- retention property. Compared to the chemical components of clay, there are many gaseous components and flux in red mud, which causes bloating and fluxing properties of red mud. The efflorescence property of red mud is directly attributed to high content of CaO and $Na_20$, and the high content of $Fe_20_3$ causes an orange-red color of red mud. [10]

**Villarejo et al. (2012):** To study the manufacturing of ceramic bricks by adding the highly hazardous waste "red mud" to a ceramic matrix and neutralizing waste in the matrix. The optimal proportion of mud to clay was found to be 50% and the resulting brick have a compressive strength greater than the pure clay. The optimal sintering temperature was 950 °C for 1 hour. For 50% red mud addition, the linear shrinkage is found to be 0.46%, water absorption 21%, weight loss after sintering 12.6% and compressive strength 52.54 MPa. The percentages of red mud increases and add to the ceramic matrix. The quantity of vitreous phase generated high. The thermal conductivity of the samples decreases as the quantity of red mud added increases due to the lower porosity produced by the greater quantity of liquid phase. [11]

**Mr. P. Ajay Kumar & Mr. M. Jayaram (2017):** The experimental work it was focus on the suitable of red mud obtained for construction. The main parameter investigate in the study of M40 grade concrete with partial replacement of cement by red mud in 0%, 10%, 20%, 30%, 40%, 50%, 60% and 5% of hydrated lime with cement in each series was added. To achieve pozzolanic property of red mud. Result show that workability is increase with increase in the percentage of red mud in concrete. The compressive & tensile strength of concrete is decrease greater than 20% of red mud. [12]

**Sithar Pateliya & Chetan Solanki (2017):** It was study the cement replaced with various percentage of red mud in concrete & checked out various mechanical properties. Red mud replace with cement start to 16% to 24% at 1% interval. It is checked for M20 M25 and M30 grade of concrete. Result shows for M20 grade of concrete increase with increase the red mud up to 18% of replacement and increase strength up to 33.95%.For M25 grade of concrete increase the red mud up to 18% then increase the strength up to 30.81%. For M30 grade of concrete increase the red mud up to 18% then increase the strength up to 9.59%. [13]

**Mustafa (2006):** To investigate the Indian company has found to effective way of utilizing alumina red mud to make bricks. There are few modified the composition of red mud was required. It is done by the incorporation of siliceous materials. Test results show that the physical property of bricks was made by either hand moulding or extrusion. It was similar to normal building bricks. In the first case the kiln was situated by the side of red storage tank. The red mud slurry directly reached through drains or pipes in the clay pits. The plastic mix could be hand moulded. [14]

**Kiran Kumar M S & Raghavendra Naik et al. (2016):** Examined the experimental investigation of red mud to effect the environment. Red mud as a partial replacement of Portland cement up to 30% by the weight of the cement and check the compressive strength after 7 days and 28 days of the concrete. Red mud and quarry dust was found to be 20% red mud+40% of quarry dust. The results show that after 7 days and 28 days improve the performance of the concrete strength. [15]

**K. Deepika & S. Ananthkumar et al. (2017):** The experimental work is to investigate the replacement of Portland cement in concrete by red mud and find the compressive and split tensile strength. The result show the revealed that 15% of cement can be optimally replaced by red mud beyond which compressive and spit tensile strength starts was decreasing. So adding the admixture the harden concrete strength it will be increase two fold strength. [16]

**Ribeiro et al. (**2012**):** Examine the high alkalinity of red mud initially effect of environment. In this study the chloride concentration was monitored by measuring the conductivity of the anolyte. Red mud proved to be a promising additive for concrete to inhibit the corrosion process. The corrosion potential was monitored by electrochemical measurements and electrical resistivity is find out. To use the sensors embedded in concrete test. The results show that the addition of red mud in concrete reduces the chloride migration rate and corrosion potential and increase the electrical resistivity. The increase red mud, the corrosion rate is low. Which stabilized between 20% by weight and 30% by weight of added red mud. [17]

**Siddu Karthik C S* & Panditharadhya B J et al. (2016):** To study the mainly focus on the compressive strength split tensile strength flexural strength & durability of properties in concrete. When use in the combination of 30% red mud, cement and 5% of lime. The result show that the compressive strength for M20 grade of concrete is 27.3N/mm$^2$ and split tensile strength is 2.60N/mm$^2$,flexural strength is 2.4N/mm$^2$.For M40 grade of concrete the compressive strength is 50.05N/mm$^2$and split tensile strength is 4.98N/mm$^2$, flexural strength is 3.29N/mm$^2$.[18]

## CONCLUSION

The review of earlier study related to partial replacement of cement with red mud reveals that there is a significant change in the strength properties of concrete such as compressive strength, split tensile strength, flexural strength. These experiments were carried out in various grade of concrete to find out the result. From the above literature reviews optimum percentage of red mud varies from 5% to 20%. Up to this percentage replacement improvement in the strength of concrete has been observed in terms of compressive strength, split tensile strength, and flexural strength on partial replacement of cement with red mud.

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