



A STUDY AND ANALYSIS OF CONCRETE STRENGTH PARAMETERS USING RED MUD AND FLY ASH AS PARTIAL REPLACEMENT OF CEMENT

Ms. Mansi Dattatray Haralkar ¹, Prof. A.N.Shaikh ²

¹PG student, Department of Civil Engineering, M.S. Bidve Engineering College, Latur

²Professor, Department of Civil Engineering, M.S. Bidve Engineering College, Latur

Abstract

The rapid industrialization prompts undeniable degrees of garbage removal items which additionally make Natural dangers. This waste can supplant the typical item, when utilized in the most proficient way. Red Mud Squander created by the aluminium business (a normal of 3million tons each year) in the Bayer interaction and Its removal is a significant issue for these enterprises as this is extremely risky and causes worldwide water Contamination, prompting wellbeing hazards. Thinking about the sloppy conduct of red mud, it tends to be applied to the innovation of concrete and solid development measures by adding a little concrete. The Utilization 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 current investigation rehashes research on the utilization 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.

Key Words – Red mud, Fly Ash, Cement

1.Introduction-

India is improved with its mineral assets store. India has exceptionally long history of the mineral removal, creation and the use. India positioned top ten among the nations who produce the mineral. The mineral enterprises go about as a back conceived of the Indian economy, as the large portion of the mechanical exercises hand-off upon the mineral as the crude materials. Disregarding this benefit the mineral ventures cause numerous ecological issues as well. The way toward mining and the material extraction prompts the waste age. The board of the Solid waste created from the businesses and the farming is the serious issue looked by India. The lack of land to store and the costlier strategy for reusing requests an elective method of arranging these solids squanders. One of the creative approaches to take care of these issues is to utilize the mechanical waste in the creation of cement. The utilization of strong waste in the solid have the two benefits as the utilization of the mechanical waste makes the solid more prudent and it will take care of the issue of the natural contamination.

Red mud is a side-effect during the assembling of the Aluminium. Aluminium is delivered from the Bauxite mineral. Aluminium is one of the generally utilized metal in food pressing industry, development industry, hardware industry, safeguard and transportation area. Light weight, high strength and recyclability make it more favoured metal for the business. There is different cycles for extraction of Aluminium from the Bauxite, like Sinter Process, Bayer Process, consolidated interaction and nepheline measure. Among the various strategies Bayer Process is the most

generally utilized technique for assembling of Aluminium. In this cycle first Bauxite is water washed, powdered and processed at exceptionally high pressing factor and temperature. After this assimilation interaction is completed. In the process the burning soft drink is added to the powdered bauxite mineral. During this cycle sodium aluminate arrangement and un-disintegrated bauxite build-up are shaped. This bauxite build-up contains silicon, iron and titanium and different materials. This Bauxite build-up which is exceptionally scathing in nature is called as Red Mud.

After studying the literature reviews, the investigations is to carry out to assess the fresh And hardened properties of concrete i.e. workability, compressive strength and Tensile Strength with some aspects of the Red Mud concrete. Most research has focused on use of Red Mud as a partial replacement of cement and effective utilization of industrial waste i.e. Red Mud in the range 0% to 20% with different percentage intervals of red mud Partial replacement of cement with red mud, issue of surface and ground water contamination Can be minimized to an incredible extent. Compressive strength, elasticity and Flexural strength of red mud mortar/ concrete continues increasing up to 20% of red mud utilized For the incomplete substitution of concrete and afterward it is reduce. Henceforth, the paper expresses that the ideal level of red mud might be suggested as about 20%.

By keeping above points the aim of this paper is to study and analyse red mud and Fly ash as a partial replacement of cement.

2.Literature Review

1|P. Syam Sai, Chandana Sukesh[2017] in this study experiments have Been performed to evaluate the quality attributes of the Aluminium red mud. Test samples were made with the Replacement of 0- 20% at an interval of 50% of red mud and 5% of hydrated lime with cement bond in M40 and M50 Grade concrete. To impart cementations property of red Mud, hydrated lime is incorporated. This study emphasizes on the promising usage of red mud in the sustainable Development.

2|Mahin Sha O B, Remya C P, Salja P A, Shifal K S [2016], In this study experiments were done to supplant the cement by red mud in concrete for various rates and to studies its impacts on the quality and different properties of the concrete. The test result shows that the addition of red mud up to 20% shows the properties of the concrete comparable with the conventional concrete.

3|Prasad N Bishetti, Leeladhar Pammar [2014] “EXPERIMENTAL STUDY ON UTILIZATION OF INDUSTRIAL WASTE IN CONCRET” he has studied that The rapid industrialization leads to the most discharge of Waste merchandise which reasons environmental risks. Those wastes may be used is conventional fabric, in construction. Red mud is a waste product came from aluminium enterprise In a Bayer’s method. Results of red mud are relatively caustic And reasons ground water infection ends in health dangers. Through taking cementitious Behaviour of red mud into Consideration, red mud is partially changed via the cement With different percentages The check has accomplished in this Test is compressive strength, cut up tensile strength of Concrete. For M30 grade of 0%,5%,10%,15%,20%,25%, red Mud replaced by means of cement at 20% the compressive strength is increase and then decreases the best cost is 20% of Red mud changed through cement. For spilt tensile strength is Reducing while growing the %of red mud. This experiments Changed into suggests that, that is used for construction with Low cost and red mud may be revolutionary supplementary.

4|RameshR.Rathod,Nagesh. T. Suryawanshi,Pravin D.Memade [2014] —EVALUATION OF THE PROPERTIES OF RED MUD CONCRETE| he has studied that red mud is wastes fabric generated from bauxite produce alumina. This waste is Negatively outcomes on environment to clear up this red mud Is in part replaced by means of cement in concrete with this We can lessen some waste and additionally cannot affect to Environment by using this replacement. The odds varying 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%, for M30 grade with The aid of using is:10262:2009. In this assessments has be Achieved with the aid of the replacement of cement with red Mud for 28 days curing the exams are compressive strength, Break up tensile strength through this from the 0% to 40%, The compressive strength price is decreases even as Increasing the proportion of red mud. The highest quality Percent is 25% barely changes in strength. And also break up Tensile strength top-rated cost is 25%, of red mud replaced by Cement it’s miles tremendous with the taken grade it’s far Appropriate for ornamental works and used in non-structural works.

5|R.Vandhiyan, K. Ramkumar et. Al. [2014], This study aims at utilization of industrial by product for value added application. Red mud is a main waste generated in aluminium production by the Bayer Process. Concrete cubes and mortars cubes were made by replacing cement with red mud in concrete 5%, 10% &15% respectively. The compressive strength, consistency and setting time tests were conducted for the above replacements. The study Indicates that red mud can be used in mortars and concretes for non-structural application. The results in this study recommend that red mud is an appealing material for use in mortars and concretes for non-structural application. The Mechanical strength diminishes with increasing proportions of red mud in place of cement, up to 10%,substitution still show suitable strength for non-structural applications. The concrete cubes made with cement replacements showed decrease in strength. The colour of the concrete changes to red with Increase in replacement. Further investigation can be done by calcinating the red mud as the properties of the material change at high temperature.

6]Mohan Kushwaha Dr. Salim Akhtar, Survesh Rajput [2013], DEVELOPMENT OF THE SELF COMPACTING CONCRETE BY INDUSTRIAL WASTE (RED MUD) he has studied that red mud is used in self-compacting concrete is an innovative concrete that doesn't require vibration for compaction. It is able to go with the flow below its own weight absolutely filling formwork and attaining full compaction. Even in presence of congested reinforcement. With the aid of partial alternative of cement with red mud it is able to be used for construction to make shape long lasting and additionally value of structure is decreases. Red mud is taken 0%,1%,2%,3%,4%,5%,6%,7%, 8%,10%, 12%,15%, 16%, partial replacement of cement and additionally mix proportions with great plasticizer was added to concrete and viscosity modifying agent is to be introduced to the cementitious fabric. On this only compressive strength check has completed in this at 2%, red mud the maximum strength is obtained after which strength is decreased with the combination of super plasticizer and viscosity modify agent strength is most at 2%, of red mud changed by using cement.

7]Sawant.A.B & S.G Sawant [2013], of KIT College of Kolhapur and Kumthekar. M. B of Govt College of engineering Karad in their paper entitled "Utilization of industrial waste (Red mud) in concrete" have discussed about the use of red mud in concrete. This paper covers significance of red mud over Portland cement by partial replacement of cement up to certain extent. Commercially available of normality in hydrochloric acid has been used for present neutralization process, because it enriches the silicon oxide and aluminium oxide content of red mud and it also eliminates harmful sodium oxide, in this paper M50 Grade of concrete mix design is carried out for 7 and 28 days of compressive strength of specimen. The decrease in initial setting time at 5% and 10% may be due to the light weight of neutralized red mud and finer particles of mud which fills the voids of the cement by which there may be increase in the density of the mix. Beyond 10% of neutralized red mud cement initial setting time increases may be due to reduction in the density of mix. The effect of replacement of cement by neutralized red mud has been studied on design mix concrete of grade M50. The water-cement ratio 0.36 is kept constant for different percentage replacement of cement by neutralized red mud. For M 50 concrete mix the optimum replacement is 15 %. It is observation that the average compressive strength decreases with increase in neutralized red mud content except for few percentage of replacement. The maximum compressive strength obtained is 60.238 N/mm², for pure cement concrete i.e. for 0% of replacement and minimum of 47.407 N/mm² with 25% of neutralized red mud at 28 days of curing period. For M50 grade concrete (0% replacement) the 28 days target strength is 58.25 N/mm. So from the studies carried out in this paper we are able to partially replace cement by neutralized red mud up to 15 %. From economical point of view the conventional concrete costing around 13.7 % more than the costing of neutralized red mud concrete (15 % replacement) with the nominal decrease in the compressive strength of 2.97 % than the actual 28 days compressive strength of M 50 grade concrete.

8]P. Ashok, M.P. Suresh kumar, et., al. [2010], were Explained 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, aluminium 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 sulphur 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 aluminium red mud. The project work focuses on the suitability of red Mud obtained for construction. ([3] P. E. Tsakiridis, S. Agatzini-Leonardou, and P. Oustadakis,)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 Pozzolan property of red mud, hydrated Lime was added. This paper points out another Promising direction for the proper utilization of red Mud.

3.AIM

A Study and analysis of concrete strength parameters using Red Mud and Fly Ash as Partial replacement of cement.

4.OBJECTIVES

- 1.To study the compressive quality, tensile strength and flexural quality of M25 Evaluation of cement by utilizing red mud, fly ash with cement.
2. The principle point of this work is use of red mud as bond which is blended With concrete To explore the effect of these waste materials on different Parameters of solid Evaluation.
3. To guarantee the ideal utilization of red mud, fly ash.
4. Production of more durable and sustainable concrete.
5. To achieve sustainable development.

6. Reduction in emission of CO in cement manufacturing by replacing it with some Cementations materials.

7. The essential goal is to sum up the properties of cement with the utilization of red mud Material.

5. Material Used-

5.1. cement

Cement, one of the most important building materials, is a binding agent that sets and Hardens to adhere to building units such as stones, bricks, tiles, etc. Cement generally refers to a very fine powdery substance chiefly made up of limestone (calcium), sand or clay (silicon), bauxite (aluminium), and iron ore, and may include shells, chalk, marl, shale, clay, blast furnace slag, slate. The raw ingredients are processed in cement manufacturing plants and heated to form a rock-hard substance, which is then ground into a fine powder to be sold. Cement mixed with water causes a chemical reaction and forms a paste that sets and hardens to bind individual structures of building materials.



CEMENT

5.2. Fine Aggregate

Fine aggregates are small-sized particles, each with a specific fine aggregate size classification, used extensively in construction. They typically consist of sand, crushed stone, or crushed slag with a diameter of less than 9.5 mm. These aggregates are essential In mixing concrete and mortar to give the mixtures a smoother consistency. Fine aggregates also help fill the tiny gaps between larger stones in concrete, improving the structure's overall stability and appearance. They are crucial for achieving the right texture and strength in various construction projects.



FINE AGGREGATE

5.3. Coarse Aggregate

Coarse aggregates are granular materials. It is often used in construction for concrete making. Its major composition includes crushed stone, gravel, or recycled concrete. Coarse aggregates typically accounts for more than 60-80% of the volume of the concrete. Their durability depends on the quality of the coarse aggregate, significantly impacting the strength and workability of the concrete. Coarse aggregates are classified as those larger than 4.75 mm according to sieve analysis, with a common diameter range between 3/8 inch (approximately 9.5 mm) and 1.5 inch (approximately 38 mm)



COARSE AGGREGATE

5.4.Red Mud

Red mud, also known as bauxite residue, is a waste product of the aluminium production process. Red mud is a brownish-red slurry that contains metal and silicon-rich oxides, rare earth elements, and iron. It's produced when bauxite ore is refined into alumina using the Bayer Process, which uses caustic soda to dissolve the aluminium silicate.

#Advantages

1.Construction material

Red mud can be used in the production of concrete, bricks, mortar, and ceramics. It can also be used as a supplementary cementitious material to replace cement. Red mud can improve the strength and durability of concrete, and reduce its permeability. It can also help with earthquake resistance, acoustics, and energy use.

2.Environmental remediation

Red mud can be used to treat wastewater, remediate soil, and purify flue gas. It can effectively remove heavy metals, organics, bacteria, and anions from liquid and solid wastes.

3.Metal recovery

Red mud is rich in iron and other valuable metals, and can be a potential resource if the metals can be extracted.

4.Catalyst

Red mud can be used as a catalyst for various processes, including hydrocarbon oxidation, hydrogenation, and hydrodechlorination.

5. Decorative material

Red mud can be used as a decorative material that prevents early fading of colour.



RED MUD

5.5.Fly Ash

Fly ash is a fine powder that is produced as a by-product of burning pulverized coal in electric power plants. It is one of the most commonly generated industrial wastes in the world, with millions of tons being produced every year. Fly ash is composed of a mixture of inorganic and organic materials, including silicon dioxide, Aluminium de, Iron oxide, calcium oxide, and Magnesium oxide. The chemical composition of fly ash varies depending on the type of coal being burned, the combustion conditions, and the type of emission control equipment used. The disposal of fly ash is a significant environmental concern, as it can contaminate air and water resources if not handled properly. Fly ash can also be a valuable resource when used as a cement replacement in The construction industry, due to its pozzolonic properties. It has been used in a variety of applications, such as making concrete, bricks, and road construction.fly ash is a fine powder that is a by product of burning pulverized coal in electric power generating plants. It is typically composed of oxides of silicon (SiO_2), aluminium (Al_2O_3), iron (Fe_2O_3), calcium (CaO), and magnesium (MgO), along with smaller amounts of other compounds. Fly ash is usually collected from the flue gases by electrostatic precipitators or bag filters.

Advantages

1.Concrete production:

Fly ash can be used as a partial replacement for cement In concrete production. It improves the strength, durability, and workability of Concrete, and reduce the amount of cement required.

2.Soil stabilization:

Fly ash can be used to stabilize soil and improve its Engineering properties including strength, permeability, and compressibility.

3 Reduced greenhouse gas emissions:

By using fly ash in concrete production, Less cement is required, which reduces the carbon footprint of the construction Industry.

4) Cost-effective:

Fly ash is an inexpensive by-product that can be used as a Substitute for expensive materials, such as cement and lime.

5) Reduced waste:

Fly ash is a by-product of coal combustion that would Otherwise be disposed of in landfills. By using fly ash, waste can be reduced and resources can be conserved.

6) Improved quality of construction:

Fly ash improves the quality of concrete by Reducing permeability and shrinkage, which improves the durability and Longevity of concrete structures.

7) Improved workability:

Fly ash makes concrete more workable, which allows For easier placement and finishing of concrete.



FLY ASH

6. Concrete Mix

The physical properties of blended cement (Portland cement replaced by 0%, 2.5%, 5%, 7.5% With constant water ratio concrete design mix of grade M25 was prepared and design mix was studied for compressive.

Cement	Fine Aggregate	Coarse Aggregate	Water
1	2.23	3.89	0.45
330.6(Kg)	738.15(Kg)	1288.05(Kg)	148.8(Kg)

7. Test for concrete

7.1. Compressive Test

To calculate the compressive strength of concrete cubes the compression testing machine (CTM) having capacity of 200 ton was used. In this test the strength obtained in tons. The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the nearest “N/mm out of many tests applied to the concrete, this is the outmost important which gives an idea about all the characteristics of concrete. For cube test most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. These specimens are tested by compression testing machine after 7 days curing and 28 days curing. Load is applied gradually at the rate of 140 kg/cm² per minute till The specimen fails. Load at failure divided by area of specimen gives the compressive strength of concrete.

Calculations

Compressive Strength= P/A

7.2. Tensile Strength Test

The Tensile Strength Test is a fundamental mechanical test used to determine the mechanical behaviour of materials under tensile loading conditions. It serves as a vital parameter in assessing the ability of a material to withstand axial forces without undergoing permanent deformation or fracture. Tensile strength, often referred to as ultimate tensile strength (UTS), signifies the maximum load a material can endure before breaking. This test aids engineers, scientists, and manufacturers in selecting appropriate materials for various applications, ensuring structural integrity, and refining production processes. By subjecting a specimen to gradually increasing tensile forces while measuring its corresponding deformation, the tensile strength test provides crucial insights into a material’s durability and performance characteristics.

#Calculations

$$\text{Tensile Strength} = 0.642P/A$$

7.3.Flexural Strength

The flexural test, also known as the three-point bend test, is a mechanical testing method used to determine the flexural strength and modulus of elasticity of a material. In this modified procedure, we will incorporate eggshell powder and fly ash as reinforcing additives to study their effects on the mechanical properties of a composite material.

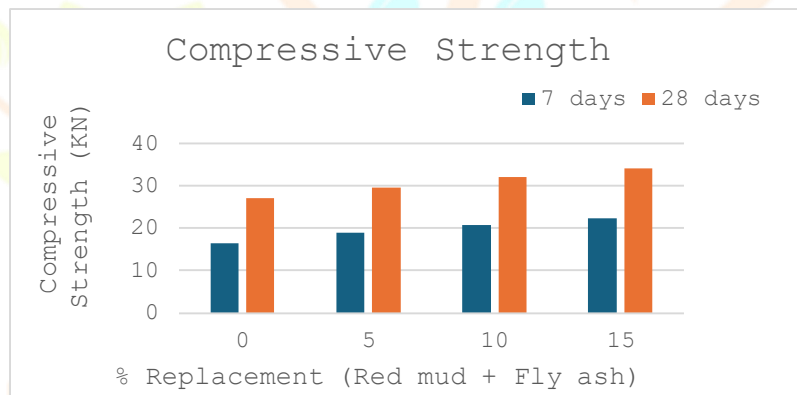
#Calculations

$$\text{Flexural Strength} = PL/BD^2$$

8.Result Analysis

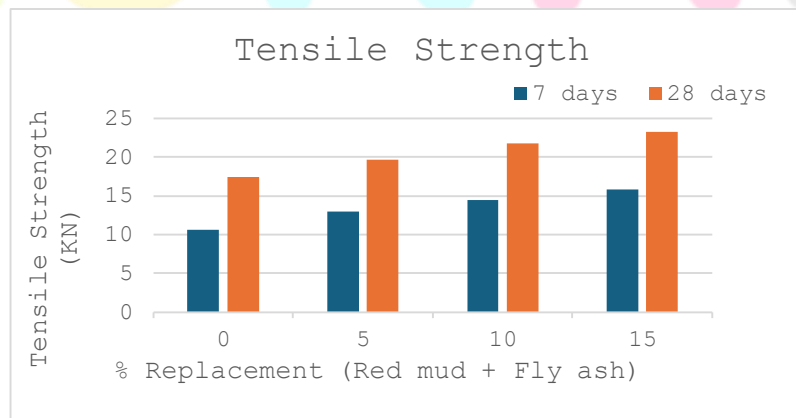
8.1.Compressive Strength

%Replacement(Red mud+ Fly Ash)	7days Compressive Strength (KN/m2)	28 days Compressive Strength (KN/m2)
0	16.40	26.96
5	19.00	29.59
10	20.78	32.15
15	22.34	34.08



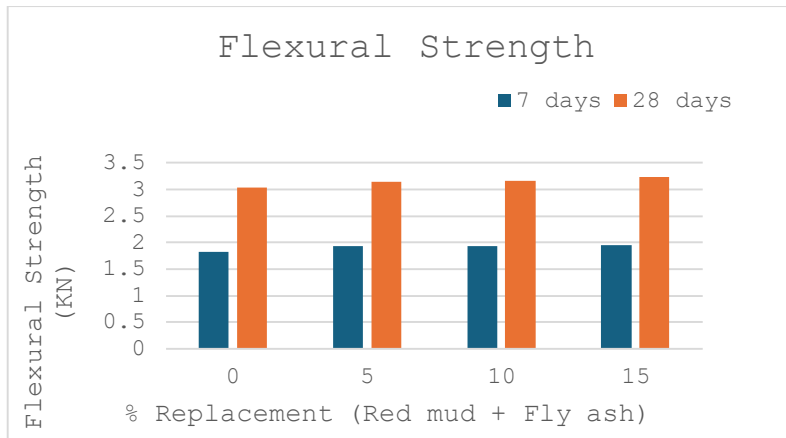
8.2. Tensile Strength

%Replacement(Red mud+ Fly Ash)	7days Compressive Strength (KN/m2)	28days Compressive Strength (KN/m2)
0	10.56	17.37
5	12.91	19.71
10	14.41	21.71
15	15.77	23.30



8.3.Flexural Strength

%Replacement (Red Mud +Fly Ash)	7days Compressive Strength (KN/m ²)	28days Compressive Strength (KN/m ²)
0	1.82	3.03
5	1.93	3.14
10	1.93	3.17
15	1.96	3.24



9. Conclusion

The following conclusion may be drawn from the experiment carried out

- 1.The compressive strength of M25 concrete for 7 days at 0%,5%,10%,15% is 16.40KN/m², 19.00KN/m², 20.78KN/m², 22.34KN/m² respectively
- 2.The compressive strength of M25 concrete for 28 days at 0%,5%,10%,15% is 26.96KN/m², 29.59KN/m², 32.15KN/m², 34.08 KN/m² respectively
- 3.The Tensile Strength of M25 concrete for 7 days at 0%,5%,10%,15% is 10.56KN/m², 12.91KN/m², 14.41KN/m², 15.77KN/m² respectively
- 4.The Tensile Strength of M25 concrete for 28 days at 0%,5%,10%,15% is 17.37KN/m², 19.71KN/m², 21.38KN/m², 23.30KN/m² respectively
- 5.The flexural Strength of M25 concrete for 7 days at 0%,5%,10%,15% is 1.82KN/m², 1.93KN/m², 1.93KN/m², 1.96KN/m² respectively
- 6.The flexural Strength of M25 concrete for 28 days at 0%,5%,10%,15% is 3.03KN/m², 3.14KN/m², 3.17KN/m², 3.24KN/m² respectively
- 7.Workability of Red mud concrete decreases with increase in percentage of replacement as compared to control mix.
- 8.Red mud did not effect of the cement properties, rather improved the cement quality by improved compressive strength.
- 9.Used for road construction as an embankment landfill is an attractive option with a high potential for large volume reuse.
- 10.Concrete prepared by using red mud is suitable in ornamental works and gives aesthetically pleasant appearance.
- 11.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.

10.Reference

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