Study on Mechanical Property of Concrete Containing Red Mud & Silica fume as a Partial Replacement of Cement

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Abstract : Red mud is a waste material generated by the Bayer process widely used to produce alumina from bauxite throughout the world. Significant research has been done to utilize red clay as a raw material for the production of various products. It can be used as building / building material in brick, block, lightweight aggregate, cement industry and special cement and concrete industry. The aim this thesis to investigate Strength Formula by replacing the Portland cement by red mud & Silica Fume. Because of storing issues, the waste negatively affects the environment. To solve this problem, Portland cement will be replaced by Red mud and silica fume and evaluating its fresh properties of concrete. Durability study will be carried out to investigate the effect of red mud powder on strength and weight of concrete specimen. The Proportion use to be verified to strength by different percentage of Red Mud and Silica Fume. By Varying Percentage of Cement is Normal, 10 % RM, 20 % RM, 30 % RM, 40 % RM, 4 % SF + Normal, 4 % SF + 10 % RM, 4 % SF + 20 % RM, 4 % SF + 30 % RM, 4 % SF + 40 % RM, 6 % SF + Normal, 6 % SF + 10 % RM, 6 % SF + 20 % RM, 6 % SF + 30 % RM, 6 % SF + 40 % RM, 8 % SF + Normal, 8 % SF + 10 % RM, 8 % SF + 20 % RM, 8 % SF + 30 % RM, 8 % SF + 40 % RM. In this Research Paper to find out above all Varying Percentage to Slump Test, Compressive Strength Test & Flexural Strength Test. Also Found out the Durability Test on Concrete, the durability test is Carbonation Test, Depth of Water Penetration, Resistance Against Alkali Attack, Chloride Attack Test. In this research Paper to we find all test result and Data Analysis to Maximum 20 % Red mud are used for construction Purpose.

Keywords : Red Mud, Silica Fume, Flexural Strength, Slump, Compressive Strength, Alkali Resistance, Sulphate Attack, Depth of Penetration, Carbonation Test all test for Durability.

I. INTRODUCTION :

Concrete is literally the material that forms the basis of modem history. More than 15 billion tons of concrete are produced each year, which is considered to be the most important building material. With the world population growing, concrete demand is expected to increase to about 20 billion tons per year by 2050. In modern society, new roads / skyscrapers, high-rise buildings and concrete that are fascinated by buildings are absolutely indispensable. Other consumption Concrete constructions include life, play and work, the movement of roads and bridges, the transport of trucks running on concrete highways, the running of rails that support concrete slippers, the mooring of ships (moorings / boats tied and protected by concrete breakwaters And is distributed by a system of concrete piers, pipes, etc., using landing and takeoff aircraft using concrete piers or concrete runways in the port.

i. Red Mud :

Red clay is rich in iron-rich residue of bauxite. It is one of the major by-products of Bayer's alumina production process. Generally, about 2 to 4 tonnes of bauxite are produced and about 1 tonne is produced, which is required for the production of each ton of alumina Al_2O_3. Since red clay is produced in large quantities, it must be stored in large trapped and impermeable ponds, so bauxite refinement is slowly surrounded by the reservoir pond. Currently, 60 million tons of red mud is produced annually worldwide, which is not satisfactorily discarded or recycled.

Red clay consists of a mixture of solid and metal oxide impurities, and one of the current aluminum industries now

has the most important disposal problem. Red mud color is caused by oxidized iron, which can account for 60% of the mass of red mud. Other dominant particles in addition to iron include silica, unbleached residual aluminum and titanium oxide. Red mud cannot be handled easily. As a waste in the Bayer process, mud is very basic with a pH between 10 and 13.

ii. Silica Fume :

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties,

it is a very reactive Pozzolana. Concrete containing silica fume can have very highstrength and, when specified, is simply added during concrete production. Placing, finishing, and curing silica fume concrete require special attention on the part of the concrete contractor.

II. HARDENED CONCRETE :

i. Compressive Strength Test :

Tests used to determine the strength of concrete under application load. Testing is performed on a compression testing machine. It was done according to IS 516-1959. For cube compression testing, typically used specimens use cube sizes of 150mm x 150mm x 150mm or 100mm x 100mm x 100mm considering aggregate size. Typically, in most jobs, a 150 mm x 150 mm x 150 mm die is used for testing. Cylindrical test specimens may also be used for compression tests of 150 mm in diameter and 300 mm in height. For compression, a tamping rod with a diameter of 16 mm and a length of 60 cm is to be used, and a gun must be located at the bottom. Concrete is filled into the mold with approximately three layers of approximately 5 cm in each layer size. Concrete distribution should be done evenly by mechanical vibrator or hand tamping. Each layer of concrete must be well compressed and the compression must be at least 35 strokes per layer using a tamping rod. Then flatten the top and then use a trowel to soften the surface. The specimen is then removed from the mold after 24 hours and kept in the water until the test is performed.

Compressive strength (MPa) = (Failure load) / (c/s area of cube specimen)

ii. Flexural Strength Test :

Determination of Flexural Strength Test is to be accordance with IS 516 – 1959. A Standard Size shall be 150*150*700 mm Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 100*100*500 mm may be used. During the casting process, the Beam mould is filled with a concrete mix of three layers with approximately the same depth. For compression, the tamping bar shall be a steel bar weighing 2 kg, 40 cm long, and shall have a ramming face 25 mm square. The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on the specimen is to be supported, and these rollers shall be so mounted that the distance from centre is 60 cm for 15.0 cm specimen or 40 cm for 10.0 cm specimens. The load shall be applied through two similar rollers mounted at the third points of the supporting span that is spaced at 20 or 13.3 cm centre to centre.

Flexural Strength, $F_b = [(P \times l) / (b \times d^2)]$

When 'a' is greater than 20.0 cm for 15.0 cm specimen, or greater than 13.3 cm for a 10.0 cm specimen, or

Flexural Strength, $F_b = [(3P \times a) / (b \times d^2)]$

When 'a' is less than 20.0 cm but greater than 17.0 cm for 15.0 cm specimen, or less than 13.3 cm but greater than 11.0 cm for a 10.0 cm specimen.

Where,

b = measured width in cm of the specimen,

d = measured depth in cm of the specimen at the point of failure,

l = length in cm of the span on which the specimen was supported and,

p = maximum load in kg applied to the specimen

If 'a' is less than 17.0 cm for a 15.0 cm specimen, or less than 11.0 cm for a 10.0 cm specimen, the results of the test shall be discussed.

iii. Durability Test :

All types of concrete elements were released for future evaluation of durability, but some preliminary tests were performed. By measuring the concrete absorption rate of the surface, you can see that the permeability of concrete, that is, its durability.

a. Alkali Resistance Test :

The resistance of the concrete to sulfate attack was studied by determining the loss of compressive strength or compressive strength of concrete cubes immersed in sulfate water containing 5% sodium sulfate (Na2SO4) and 5% magnesium sulfate (MgSO4) Sulfates Not immersed in water. The concrete cube of 150 mm size, which is cured for 28 days and dried for one day, is immersed in 5% Na2SO4 and 5% MgSO4 for 90 days. The concentration of sulfate was maintained during that period. After 90 days of immersion, the concrete cube was taken out of the sulphate water and wiped off the water and soil from the cube surface which had been tested for compressive strength according to the procedure specified in IS: 516-1959. Evaluation of the sulfate resistance of this type of accelerated test concrete Loss of compressive strength for.

For alkaline attack tests, concrete cubes of size 150x150x150 mm are prepared against various barite powder addition ratios. The specimens are cast in a mold for 24 hours and cured for 24 hours, then all specimens are molded and stored in a hardened tank for 7 days. After 7 days, all specimens are stored in air for 2 days at a constant weight, weigh the specimens and immerse them in 5% sodium sulfate (Na2SO4) solution for 60 days. The pH value of the alkaline medium was 12.0. The pH value was checked periodically and maintained at 12.0. After immersing in an alkaline solution for 60 days, remove the specimen, wash it in running water, and leave it in the air for two days with a certain weight. Next, the weight of the test piece is measured and the weight loss is calculated to calculate the weight loss rate.

b. Sulphate Attack Test :

A 5% sodium chloride (NaCl) solution was used as the standard exposure solution for all tests. The test specimens were immersed in a sodium chloride solution in a plastic container and the volume ratio of the sulfate solution to the sample was maintained at 4:1. Changes in mass and compressive strength were observed at regular intervals.

c. Depth of Penetration Test :

Carbonation of a concrete is a process by which carbon dioxide from the air penetrates into concrete through pores and reacts with calcium hydroxide to form calcium carbonates. It has been seen that the conversion of $Ca(OH)_2$ in to $Caco_3$ by the action of Co_2 results in a small shrinkage.

$$Ca(OH)_2 + Co_2 \Longrightarrow CaCo_3 + H_2O$$

Concrete Chemistry is Obviously though to Understand for a small house owner. Spending some amount towards Concrete Carbonation test is an excellent idea to know the effect of atmospheric Co_2 on the RCC Structure. The Concrete Carbonation test for in situ concrete is associated with the Corrosion of Reinforcement steel. Due to the Concrete Carbonation, Reinforcement corrosion often occurs on the building facades which are exposed to moisture, rainfall and shaded from sunlight. The steel corrosion in concrete also occurs due to the Carbonation, when the concrete has a least cover over the steel Reinforcement. The Carbonation of Concrete occurs when the level of humidity in the atmosphere is ideally between 50 to 70 %. The Carbonation is worse in hot environments. The measurement of Carbonation depth using the phenolphthalein Solution. Spraying the indicator on the Surface of the concrete Cube. The Solution became a Pink Colour in the Carbonated Concrete. it can be differentiated from the uncarbonated Concrete. Carbonation depth up to an accuracy of 5 mm can be identified with the naked eye.

d. Carbonation Test :

For dense and, hence, low permeability concrete, the depth of penetration method is usually a more practical proposition than permeability flow tests. The basic Procedure for such as depth of penetration test is to apply water under pressure to one surface of the specimen for a specific time and then to split the specimen perpendicular to the injected face and determine visually the depth of penetration. The method is covered by BS EN 12390 – 8 : 2000 Testing hardened concrete – Part 8 Depth of Penetration of water under Pressure.

III. CONCLUSION :

- Compressive strength of concrete produced by replacing cement by red mud goes on increasing up to 20% replacement of cement by red mud and reaches peak at 20%.
- Compressive strength of concrete produced by replacing cement by red mud and silica fume goes on increasing up to 20% replacement of cement and 4% silica fume reaches peak at 20%.
- Compressive strength of concrete produced by replacing cement by red mud and silica fume goes

on increasing up to 20% replacement of cement and 6% silica fume reaches peak at 20%.

- Compressive strength of concrete produced by replacing cement by red mud and silica fume goes on increasing up to 20% replacement of cement and 8% silica fume reaches peak at 20%.
- For 20% replacement of cement by red mud gives the optimum content of red mud which gives highest strength of concrete.
- For 20% red mud and 4% silica fume replaced with cement gives optimum dosage which gives higher compressive strength of concrete as compare to concrete mix in which cement was only replaced by 20% cement.
- For 20% red mud and 6% silica fume replaced with cement gives optimum dosage which gives higher compressive strength of concrete as compare to concrete mix in which cement was only replaced by 20% cement.
- For 20% red mud and 8% silica fume replaced with cement gives optimum dosage which gives higher compressive strength of concrete as compare to concrete mix in which cement was only replaced by 20% Red mud and cement was replaced by 20% Red mud along with 4% and 6% Silica fume mud.

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