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Experimental Study on High Strength Concrete Using Industrial Wastes

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Abstract-Generally the river sand is used as a fine aggregate on concrete and is obtained by mining the sand from river bed. Increased sand mining not only affects the aquifer of the river bed but also causes environmental problems. In recent days demand for river sand is increasing due to its lesser availability. Therefore the practice of using industrial by-products is of great use now. It not only reduces the use of natural sand but also eliminates the problem of disposal of these wastes. Such industrial wastes now-a-days find a great threat to the environment because of their disposal problem. This project deals with the replacement of both the binder and fine aggregates. Various strength parameters are to be studied and compared with the standard results of conventional concrete. Further, Micro structure analysis using TEM will also be studied in this study.
Key Words: High Strength Concrete, Metakaolin, Micro-structure study.

I. INTRODUCTION

Concrete is a very strong and versatile mouldable construction material. It consists of cement, sand and aggregates (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years. . Increasing extraction of natural sand from river bed causing many problems, loosing water retaining sand strata, deepening of the river courses and causing many bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting the agriculture due to lowering the underground water table etc., are few examples. In past decade variable cost of natural sand used as fine aggregate in concrete increased the cost of construction. In this situation research began for inexpensive and easily available material to natural sand.

II. REVIEW OF LITERATURES

Ravindra Gettu et al., investigated the fracture properties and brittleness of high strength concrete. In this experiment, geometrically similar three-point bending specimens were tested and the measured peak load values were used to obtain the fracture energy, the fracture toughness, the effective length of the fracture process zone, and the effective critical crack-tip opening displacement. The concrete mix was designed to exceed a 28-day compressive strength of 83 MPa. Beam specimens of four different sizes, three in each size, were cast from the same batch of concrete. A notch of 2mm was made in the beam. The length of the notch was one-third the depth of the beam. The three-point bending test was used due to the relatively simple test setup and the impossibility of crack bifurcation. The test results from the largest beams were, however, excluded from the following analysis because their load values were inconsistent with the trend of the other tests. In retrospect, this inconsistency may be due to the difference in control parameters used for testing and in machine characteristics.

Rafat Siddique et al., studied the Effect of used-foundry sand on the mechanical properties of concrete. The experiment involved the replacement of fine aggregate with 10%, 20% and 30% of foundry sand. Compressive strength, split tensile, flexural strength and modulus of elasticity were determined for 28, 56, 91 and 356 days. All the characteristic strength increased with the increase in the foundry sand and also increased with the age. Increase in compressive strength varied between 8% and 19% depending upon UFS percentage and testing age, whereas it was between 6.5% and 14.5% for splitting-tensile strength, 7% and 12% for flexural strength, and 5% and 12% for modulus of Elasticity. It was also reported that the use of foundry sand as replacement of sand increased with the age. Therefore this paper recommends the use of foundry sand to be effective in making good quality concrete.
P Sravana et al., investigated the Impact strength of high volume fly ash fibre concrete with fly ash as an additional material. The experimental investigations were carried out to study the impact strength of ordinary concrete and high volume fly ash concrete

using 50 percent fly ash as an addition with different percentages of steel fibres' at 28 and 90 days. It was found out that the impact strength increased due to addition of steel fibres to high volume fly ash concrete. The ultimate impact strength of high volume fly ash concrete of w/b 0.36 with 1.5% steel fibres at 90 days increased by 50% with respect to ordinary concrete with 1.5% steel fibres. The Ultimate Impact Strength of high volume fly ash concrete with 1.5% steel fibres at 90 days increased to 400% with respect to without fibres.

B. B. Patil, presented a thesis about the Strength and Durability Properties of High Performance Concrete incorporating High Reactivity Metakaolin. High Performance Concrete of grade M60 with water-cement ratio 0.31 were made in this experiment. The cement has been replaced with 5%, 7.5%, 10%, 12.5%, and 15% by Metakaolin. The desired workability was achieved with optimum Metakaolin of 7.5% and superplasticizer of 0.73%. The 28 days test of cube compression test indicated that concrete with 5%, 7.5% and 10% showed increase in strength while for other percentages there was a decrease in strength because of dilution effect. The durability characteristics like chloride ion penetration and sulphate attack were also studied. The 7.5% addition of High Reactivity Metakaolin (HRM) has given enhanced resistance to chloride attack. The 7.5% addition of HRM in cement also enhanced the resistance to sulphate attack.

Gurpreet Singh carried out an experimental research on the effects of waste foundry sand (WFS) as partial replacement of sand on the strength, Ultrasonic Pulse Velocity and permeability of concrete. The natural sand has been replaced with 0%, 5%, 10%, 15%, and 20% by WFS by weight. In this study, five concrete mix proportions with and without Waste Foundry Sand were made. In case of durability property, Rapid Chloride Permeability test was performed on all five mix proportion at the age of 28 and 91 days. From the experiments it was observed that partial replacement of sand with WFS (up to 15%) increased the strength properties (compressive strength, splitting tensile strength and modulus of elasticity) of concrete. Maximum increase in compressive strength, splitting tensile strength and modulus of elasticity of concrete was observed with 15% WFS, both at 28 and 91 days. Inclusion of WFS increased the USPV values and decreased the chloride ion penetration in concrete, which indicates that concrete has become denser and impermeable.

Nova John investigated the strength properties of Metakaolin Admixed Concrete. High strength concrete of M30 grade was prepared and the replacement levels were 5%, 10%, 15% and 20%. The experimental results showed that the replacement of Metakaolin up to 15% showed increase in the compressive strength, split tensile strength and flexural strength. Beyond the addition of Metakaolin resulted in the decrease of the strength.

K. Ramesh et al.,carried out an Experimental Investigation on Impact Resistance of Flyash Concrete and Flyash Fiber Reinforced Concrete. The study was made with the addition of steel fibers. Steel fibers varied from 0%, 0.5%, 1% and 1.5% by weight of cement and replacement of fly ash varied from 0%, 10%, 20%, 30% and 40% by weight of cement. Specimens were tested for 28 days, 60 days and 90 days and behaviour of the flyash concrete, steel fiber reinforced concrete and flyash concrete reinforced with steel fibers were studied. It was found that the amount of steel fibers which can be added to the concrete for improving its strength characteristics may be 1% by weight. Addition of steel fibers more than 1% generally affects the Impact strength of the concrete. Based on the analysis of test results, it has been concluded that cement in concrete can be replaced upto 30% by flyash with incorporation of steel fibers upto 1.5% to improve its strength characteristics.

Maria Teresa Gomes Barbosa & Souza Sánchez Filho investigated the bond stress in pull out specimens with high strength concrete. Study consists of pull out tests of Brazilian's steel, with five different concrete strength 20, 40, 60, 80 and 100 MPa, and three different steel bars diameter 16.0, 20.0 and 25.0 mm. Pull out tests were conducted on concrete of different strengths and with three different steel bars diameters. As many as nine specimen test were made, for each diameter and different strength of concrete, which was evaluated at the 3, 7, 28 and 90 days of age. The test result showed that if the bar diameter increases the bond stress increases. The pull out test placed the concrete surrounding the bar in compression and the bar in tension, but in practice both the bar and the concrete are in compression.

Dr.K.Srinivasu et al.,made a review on the use Metakaolin in cement mortar and concrete. In this study, concrete was prepared for M50 grade. The experiment involved the replacement of 5%, 10%, 15%, 20%, with 0%, 0.5%, 1% and 1.5% by addition of steel fibres. The test report showed that the cement replacement with 20% Metakaolin gave maximum enhancement in pore refinement of pastes and compressive strength got reduced when Metakaolin addition went beyond 30% as cement replacement. The viscosity and shear stress improved when Meatakaolin was replaced to 10% and 15%respectively. The optimum value was found out for replacement of cement with 10% MK and 1% addition of steel fibres. It was reported that the durability property like resistance to

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chloride ion penetration was increased when replacement up to 0%, 4%, 6% and 8% were made.

III. NEED FOR THE STUDY

Many industries now-a-days produce enormous amount of waste materials. These materials in due course pose a great challenge in disposing of materials. These in turn result in environmental threats and cause serious problems. Therefore researchers started using these products in the construction field as an alternative material for binder and for fine aggregate. Various researches were performed with varying percentages of binder and fine aggregate and found the optimum value where there is considerable strength gain. They are then compared with the standard test results and then the properties were studied. The use of green sand with 100% replacement produced increased in strength with increasing in curing period. Though, the replacement of marble powder with higher percentage were found to increase but with the increasing in curing period there was a considerable decrease in strength gain. Therefore in this paper, the green sand and marble powder are to be replaced from 0%, 5%, 10% and to 20%.

IV. CONCLUSION

In this present study, the Ordinary Portland Cement is to be replaced with Metakaolin, a similar pozzolanic material by 5% weight of cement. The river sand is then replaced with Green sand and Marble powder by 0% to 20% by weight with every increase in 5% by weight of sand. The water cement ratio is to be kept as 0.4. Superplasticizer is added to improve the workability of the concrete. Fracture toughness test with three point and four point loading, shear strength test, impact strength, bond strength and UPV are to be performed. Further the variation in the micro structure in each mix are to be performed using Transmission Electron Microscopy.

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