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Experimental Investigation on Bond Strength, Impact Strength and UPV of Concrete with Industrial By-Products

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Abstract: The present Experimental investigation is to study the Bond strength of the concrete, Impact Resistance and durability study by ultrasonic pulse velocity of concrete with partial replacement of Metakaolin and GGBS(Ground Granulated Blast-furnace Slag) as binder and Copper slag as fine aggregate. Metakaolin and GGBS are varied from 5%, 10%, 15% by the weight of cement and copper slag varied from 10%, 20%, 30%, 40%, 50%, 60% by the weight of fine aggregate. Mix design is done for the M30 grade concrete with 0.38 w/c ratio. We have use the water reducing admixture as super plasticizer to maintain the water cement ratio within the minimal range. Specimens are going to test for 28 days. A through literature review was conducted to study and investigate the properties of these materials and testing methods. In this research, it is proposed to study the bond strength of the concrete by pullout test methods and Bond in reinforced concrete (RC) refers to the resistance of surrounding concrete against pulling out of reinforcing bars which embedded in the concrete. The specimens for impact studies can test by using drop weight method test which was recommended by ACI-544 Committee. Ultrasonic pulse velocity test have been conduct to determine material properties, detect defects and assess deterioration of the concrete.
Keywords: Abstract, Introduction, Literature Review, Need for Study, Conclusion.

I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing cementitious materials, water, aggregate and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be moulded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age. The usage, behaviour as well as the durability of concrete structures, built during the last first half of the century with Ordinary Portland Cement (OPC) and plain round bars of mild steel, the ease of procuring the constituent materials (whatever may be their qualities) of concrete and the knowledge that almost any combination of the constituents leads to a mass of concrete have bred contempt.The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. GGBS, High Reactive Metakaolin, are the pozzolanic materials which can be used in concrete as partial replacement of cement and Copper slag as partial replacement of fine aggregate. Metakaolin and GGBS are varied from 5%, 10%, 15% by the weight of cement and copper slag varied from 10%, 20%, 30%, 40%, 50%, 60% by the weight of fine aggregate Mix design is done for the M30 grade concrete with 0.38 w/c. The combination of mix ratio were taken as 5%, 10%, 15% for each 10%, 20%, 30%, 40%, 50%, 60% of replacements. Totally 19 number of mix ratios were taken.

II. LITERATURE REVIEW

Mahendran K & Arunachelam N (2015), done a study on "Utilization of Copper Slag as Fine Aggregate in Geopolymer Concrete". In this study the sand is replaced with copper slag in geopolymer concrete varying the percentage of 10, 20, 30, 40 and 50 %. The ratio between sodium hydroxide to sodium silicate is taken as 1:2.5 with the concentration of 10M for sodium hydroxide solution. The quantity for fly ash and coarse aggregate was kept constant as 550 Kg/m3 and 1020.81 Kg/m3 respectively. Naphthelene sulphonate based superplasticiser is used to improve the workability of the concrete. The dosage of the superplasticiser is 4 % to the fly ash, water of 11 Kg/m3 is added to get the consistent mix. Low calcium fly ash based Geopolymer concrete with 10M sodium hydroxide concentration and copper slag as a partial replacement for natural river sand shows compressive strength and split tensile strength of 71.2 N/mm2 and 4.95 N/mm2 when cured at 60˚C, while ambient cured concrete. Increase in the content of copper slag in place of sand, strength of concrete increases this may be influenced by presence of higher amount of silica in copper slag compared to the sand.

Nithya B et al., (2015), focused on "A Comparative Study on Bond Strength of Reinforcing Steel in Bottom Ash Concrete and Controlled Concrete". The concrete was made with Portland cement, Fine aggregate and Coarse aggregate in the weight ratio 1:1.7:3. The water-cement ratio was 0.52. The pull-out specimens were designed using IS: 2770 (Part I) - 1967 as a guide. All the test specimens were cured for 28 days. The specimens were reinforced with a helix of 6 mm diameter the size of cube. The test specimens consist of concrete of size 10mm, the size of cube. The test specimens consist of concrete cubes of size 150 mm, with a single reinforcing bar of 16mm diameter, embedded vertically along a central axis in each specimen. For the specimens studied in this investigation, it appears that bottom ash concrete possesses bond strength almost same as that of controlled concrete. Overall behaviour of Load vs Slip and Bond stress vs Slip of bottom ash concrete was very similar to that of controlled concrete.

Srishaila J M et al., (2014), made on "Combined Effect of Ground Granulated Blast Furnace Slag and Metakaolin on Mechanical Properties of Self Compacting Concrete". The Ordinary Portland cement is replaced by (Metakaolin 3%+GGBS 5%,15%,25%), (Metakaolin 6%+GGBS 5%,15%.25%), (Metakaolin 9%+GGBS5%) percentage and super-plasticizer is also added to get workability. Totally seven mix designs are prepared and the properties are checked in fresh state and hardened state. The tests are conducted for 7,28,56,90 days for the hardened concrete. The compressive, split tensile, flexural strength is maximum for the mix proportion Metakaolin 6% and GGBS 15% and is higher by 44% with respect to first mix. The Ultrasonic Pulse Velocity test values show that the concrete compaction is good without any external vibration. An RCPT value shows that as the percentage of GGBS and Metakaolin increases the chloride ion permeability will be low and 56 days compressive strength is higher by 13%if compared to 28 days strength of all mixes.

Nipun Verma & Anil Kumar Misra (2014), analysed "Bond characteristics of reinforced TMT bars in Self Compacting Concrete and Normal Cement Concrete". The main aim of this study is to evaluate the advantages of SCC quantitatively, an experimental program was conducted to measure the bond strength of reinforcing bars in SCC as well as in normal concrete. The Normal Cement Concrete (NCC) specimens were casted using conventional construction practice. Specimens were casted in 150 mm cube moulds with embedded reinforcing bars of diameter 16 mm (ribbed) in each specimen. The specimens were cured in water for 3, 7, and 28 to avoid changes in the curing conditions and 2 specimens for each concrete age. Use of carboxylic acid-based type of super-plasticizer in SCC can produces more uniformity. The bond strength in NCC is maximum for 0.4 W/C ratio for 3, 7 and 28 days, while the bond strength in SCC is maximum for 0.4 W/C ratio for 3, 7 and 28 days. The bond strength for SCC increases rapidly as compared to NCC for 0.4 W/C ratio and bond strength for SCC almost equals the bond strength value for NCC for 0.5 and 0.6 W/C ratio for 7 and 28 days. Modified UTM machine can be used for measuring the bond stress and it is easily and economically feasible.

Ramesh Ketal., (2013), made study on "Experimental Investigation on Impact Resistance of Flyash Concrete and Flyash Fiber Reinforced Concrete". The present Experimental investigation is to study the Impact Resistance of the Fly ash concrete reinforced with steel fibers. The concrete composite comprises of steel fibers in different percentages and partial replacement of cement in different proportions. 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. The specimens for impact studies were tested by drop weight method which was recommended by ACI-544 Committee. The size of the specimen recommended by ACI committee is 152 mm diameter and 63.5 mm thickness and the weight of hammer is 4.54 Kg with a drop of 457mm. it is concluded as that drawn. 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. The optimum steel fiber may be added to the concrete without flyash may be taken as 1%. The optimum steel fiber may be added to the concrete with flyash may be taken as 1.5%. It was found that the amount of flyash which can replace cement in concrete for improving its strength characteristics at 90 days was 30% by weight. Based on the analysis of test results, it is 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.

Ismail Ozgur Yaman et al., (2001), studied "Ultrasonic Pulse Velocity in Concrete Using Direct and Indirect Transmission". Measurements were performed on two plain concrete slab specimens with dimensions of 1500 mm width, 1000 mm length, and 250

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mm thickness. Direct and indirect UPV measurements were made simultaneously on the slab specimens at an age of 28 days. Indirect UPV was computed as the ratio of wave path length between the transmitting and receiving transducer to the time of flight. Using different definitions for wave path length such as center-to-center or edge to edge of the transducers resulted in large differences in indirect UPV. In the second approach, measurements were made along a line on the surface of the concrete specimen with increasing separation between transmitting and receiving transducers. It is recommended that the first measurement is made at approximately two wavelengths from the transmitting transducer and the transducer separation is increased for consecutive measurements with approximately 50 mm intervals (half wavelength). The average indirect UPV was determined to be 4500mis when computed using four measurements performed with transducer spacing of 200 to 350 mm. The corresponding average standard error was about 100mis. The most significant conclusion is that the indirect UPV is statistically similar to direct UPY measured on the concrete slab specimens provided that there are uniform properties, including moisture gradient along the surface and along the depth as a function of specimen size is in agreement with the physical implications of the size effect law and supports its applicability.

III. NEED FOR STUDY

A. To determine the mix proportion with partial replacement of metakaolin, ground granulated blast furnace slag as binder and copper slag as fine aggregate to achieve the desire needs.
B. To determine the water/ binder ratio, so that design mix having proper workability and strength.
C. To investigate strength of concrete such as compressive strength, bond strength, impact strength, ultrasonic pulse velocity.
D. To effectively utilize the industrial waste by products such as GGBS and Metakaolin by decreasing the use of Ordinary Portland Cement.

IV. CONCLUSION

In this present study, cement has been partially replaced by alternative materials like metakaolin and ground granulated blast-furnace slag and the fine aggregate has been partially replaced by copper slag. The literature serving the concrete are collected to obtain the correct mix proportion to be adopted and they are metakaolin and GGBS are varied from 5%, 10%, 15% by the weight of cement and copper slag varied from 10%, 20%, 30%, 40%, 50%, 60% by the weight of fine aggregate. Admixture of about 0.75% of superplasticizers by weight of cementations material is to be added. Test for fresh concrete such as slump test, compaction factor test and test for hardened concrete such as bond strength on cube with embedded bars, compressive strength on cubes, impact resistance on disc and ultrasonic pulse velocity on cubes are to be conduct for 28 days.

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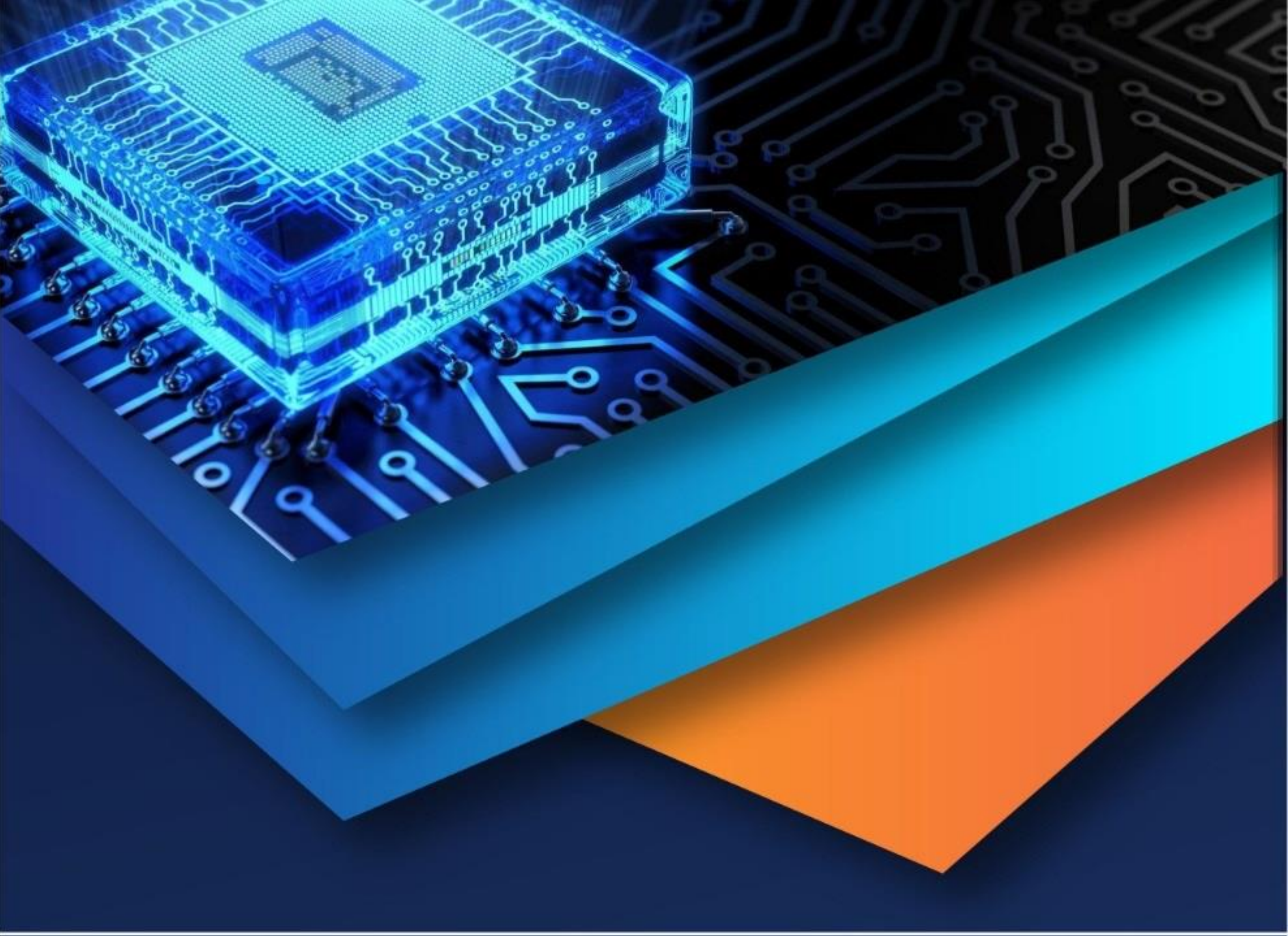

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