iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** V **Month of publication:** May 2016

DOI:

Volume 4 Issue V, May 2016
ISSN: 2321-9653

Experimental Behavior on Mechanical Properties of Concrete Using Industrial Byproducts

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Abstract: The necessity of high strength concrete is increasing because of demands in the construction industry. To get the high strength for concrete by reducing the water content can achieve by adding the chemical admixture and some other properties also to be enhanced like durability, low permeability and good workability by adding pozzolanic materials to concrete.This study investigates the mechanical properties of concrete with industrial by product. Incorporation of these admixture reduces the cement content in concrete .The reduction of cement content means it minimize the environment impacts caused in cement production process and most of these materials are industrial by-products, problems with disposal also can be solved. As part of research efforts to develop cement less concrete using metakaolin and GGBS as binder, copper slag is partially replaced with fine aggregate. In this research, Portland cement was partially replaced by 5%, 10% of metakaolin and GGBS. This combination of mix ratio were taken for each 20%, 40%, 60% replacement of fine aggregate with copper slag. The water to cementations materials ratio was maintained at 0.38 for all mixes. The strength characteristics of the concrete were evaluated by conducting Compressive strength test for 28days,56days and 90days of curing and flexural &split tensile strength test were conducted for28&56days of curing on a M30 grade concrete.

I. INTRODUCTION

Concrete is the most extensively used material in civil engineering construction so that considerable attention is taken for improving the properties of concrete with respect to strength and durability. Numerous types of concrete have been developed to enhance the different properties of concrete.The most important part of concrete is cement. The production of Portland cement consumes considerable energy and at the same time contributes a large volume of CO2 to the atmosphere. The climate change due to global warming has become a major concern. The global warming is caused by the emission of greenhouse gases, such as carbon dioxide (CO2), to the atmosphere by human activities. The cement industry is held responsible for some of the CO2 emissions, because the production of one ton of Portland cement emits approximately one ton of CO2 into the atmosphere. However, Portland cement is still the main binder in concrete construction prompting a search for more environmentally friendly materials. Several efforts are in progress to supplement the use of Portland cement in concrete in order to address the global warming issues. These include the utilization of supplementary cementing materials such as Ground granulated blast furnace slag and metakaolin and the development of alternative binders to Portland cement.

River Sand is common form of fine aggregate used in the manufacturing of concrete. However because of increased cost and large scale depletion of sources alternatives for river sand are being considered. The use of sand from the river beds affects the vegetation, aquatic life and reduces the ground water level in the surrounding areas. There have been many alternative materials with similarphysical & chemical properties of Sand found (Lime stone waste, marble powder, furnace slag and welding slag, stone dust etc.) and research have being carried out to check the suitability of its use as partial replacement of sand. Copper Slag is an industrial by-product abundantly available near copper producing industries having similar physical &chemical properties of Sand can be considered as an alternative to the river sand. This will help in resolving a major concern of industrial waste disposal along with decreased cost of construction.

II. LITERATURE REVIEW

Dinakar P et al.,(2015),studied the “Effect of Metakaolin Content on the Properties of High StrengthConcrete” where cement content was partially replaced with 5, 10, and15 % MK (by mass) respectively.In this study, different SP dosages were added to the different mixtures in order to obtain the consistency or workability in terms of target slump of 100 ± 25 mm.It can be seen that, the SP demand increased with increase in the metakaoiln replacements. This study shows that by utilizing local MK and cement designed for a low water/binder ratio of 0.3, high strength and high performance concretes can be developed and compressive strengths of more than100MPa can be realized. The optimum replacement level of OPC by MK was10 %, which gave the highest compressive strength in comparison to that of other replacement levels; this was due to the dilution effect of partial cement replacement. Splitting tensile strengths and elasticmodulus results have also followed the same trend to that of compressive strength results showing the highest values at 10 % replacement.Using local MK found to reduce water permeability, absorption and chloride permeability as the replacement percentage increases. This may be due to the filler effect of MK particles which has substantially reduced the permeability or porosity of the concrete.

PranshuSaxena (2015),analysed the **"**experimental study on mechanical properties of m30 concrete with partial replacement of cement and fine aggregate with silica fume and copper slag". It designed to investigate the effect on the mechanical properties of the concrete by using copper slag as a partial replacement for fine aggregate with different proportions *viz*., 10%, 20%, 30%, 40% and 50% and with the fixed amount of silica fume i.e. (10%) as a partial replacement for cement. cubes of size150 x 150 x 150 mm were casted for all the concrete mixes. All the cubes were tested in saturated condition after wiping out the surface moisture. Two cubes fromeach mix were tested and there average values were used in the analysis using compression testing machine (CTM).The compressive strength of the new concrete increased with the increase in copper slag content up to a replacement level of 40%, maximum compressive strength of concrete increased by 58% at 40% replacement of fine aggregate by copper slag. The tensile strength of the new concrete has increased up to a replacement percentage of 40%, maximum tensile strength of the new concrete increased by 33% at 40% replacement of fine aggregate by copper slag.Maximum flexural strength of the new concrete increased by 25% at 40% replacement of fine aggregate by copper slag. Beyond the replacement level of 40% of fine aggregate with copper slag in concrete, a decrease in strength was observed.

Monika Y.E et al., (2015),studiedthe "behavior of blended self-compacting concrete using industrial byproduct" where cement is partially replaced 5%,10%,15% with Silica fume and metakaolin. There was an increase in the strength of SCC when the cement is replaced by MK & SF up to 15%.This also reduces the cement content by increasing the MK &SF thus reducing the further cost of SCC mixes developed. Using the combined mixing of SF & MK as a cement replacement level between 5-15%, SCC mixes can be achieved with good flow characteristics and better compressive strength. MK & SF can be very good replacement for cement with respect to economy, strength and the considerations of availability of resources.

Christina Mary V and Kishore CH (2015) made on "Experimental investigation on strength and durability characteristics of high performance concrete using GGBS and m-sand". This research work focuses on strength and durability characteristics of M40 grade concrete with replacement of cement byGGBS with 10%, 20%, 30%, 40% and 50% and replacement of natural sand by Msand with 50% and compares it with conventional concrete. Compressive, split and flexural test were conducted on concrete specimens for strength analysis Cubes (150x150x150 mm), Cylinders (75x150 mm), prism (100x100x500 mm) were casted for strength characteristics. For durability studies cubes (100x100x100) for Acid attack, Cylinders (100x200) are casted for RCPT and Sorptivity were casted. Specimens were kept under water curing for 28 days and were taken for testing.Based on the compressive strength results, the maximum compressive strength at all ages of testing was obtained at (M1)10% GGBS and 50% M-sand optimum replacement, corresponding to an increase of 10.25%,6.12% and 5.66% compared to the14-days, 28-days and 56-days compressive strength of conventional concrete. While comparing the split tensile strength results, HPC mix containing 10% GGBS and 50% M-sand (M1) achieved greater split tensile strength when compared with conventional concrete. High performance concrete mix (M1) has achieved 0.85% higher value than conventional concrete. The flexural strength results have shown that high performance concrete with 30 % GGBS and 50% M-sand (M3) has got highest flexural strength compared with conventional concrete. The percentage increase in flexural strength is 75.36% higher when compared with conventional concrete. Based on results from RCPT graph, it is understood that the chloride diffusion is moderate in M1 (10% GGBS and 50% M-sand) and control mix. The M1 mix is enhanced resistance to chloride attack. The compressive strength of concrete incorporating 10% GGBS and 50% M-sand is reduced only by 3.55% as compared with the reduction of strength of control mix specimen by 4.38%.

Dharani .N et al, (2015),studied the"study on mechanical properties of concrete with industrial wastes"**.** In this paper M25 grade mix was designed as per IS 10262-2009 and the mix proportion was found to be 1:1.80:2.95 with w/c ratio of 0.5. Hypo sludge was used as a replacement material for cement and copper slag was as a replacement material for fine aggregate. The replacement percentage adopted were 10%, 20% & 30% for Hypo sludge and 30%, 40% & 50% for copper slag. In order to investigate the mechanical property, cubes of 150 mm x 150 mm x 150 mm size, cylinders of 150mm diameter and 300mm length and prisms of 100 mm x 100 mm x 500 mm were cast. Optimum of 50% replacement of fine aggregate by copper slag shows increase in compressive strength when compared to conventional mix. With 10% replacement of cement by Hypo sludge shows increase in compressive strength when compared to 20% and 30% replacement mix. Optimum of 10% replacement of cement with Hypo sludge and 50% replacement of fine aggregate with Copper slag shows increase in compressive strength compared to other combinations.10% and 20% replacement of cement with HS shows little variation in compressive strength based on curing days. With increase in curing days 40% replacement of fine aggregate with copper slag shows increase in split compressive strength. Optimum of 10% replacement of cement with Hypo sludge and 40% replacement of fine aggregate with Copper slag shows increase in split tensile strength compared to conventional mix. At 40% replacement of fine aggregate by copper slag shows increase in split strength. With increase in curing days 30% replacement of cement with hypo sludge shows decrease in split tensile strength when compared to other combinations. Optimum of 10% replacement of cement with Hypo sludge and 50% replacement of fine aggregate with Copper slag shows increase in flexural strength compared to conventional mix.

Karthick J (2014),analysed the **"**Experimental Study on Strength Characteristics on M20 Concrete with Partial Replacement of Cement with Fly ASH and Replacement of Fine Aggregate with Copper Slag**".** For this study M20 grade concrete were used and the tests were conducted for various proportions of copper slag replacement with sand (0%, 10%, 20%, 30%, 40% & 50%) and partial replacement of fly ash with cement 30% in concrete. Cubesand Cylinders, Prism specimens were cast and tested for compression, split tensile strength and Flexural strength test. The compressive strength of concrete cubes with 40% replacement of fine aggregate with copper slag shows an increase of 15% when compared to the normal concrete Cube. In the similar manner, there was increased in the split tensile strength of concrete with 40% replacement of fine aggregate with copper slag shows an increase of 34% when compared to conventional concrete. The flexural strength of prism with 40% replacement of fine aggregate with copper slag shows an increase of 28.57% when compared to the normal concrete prism. With higher levels of replacement (100%) there has bled during cast and recommended that up to 40% of CS can be used as replacement of sand.

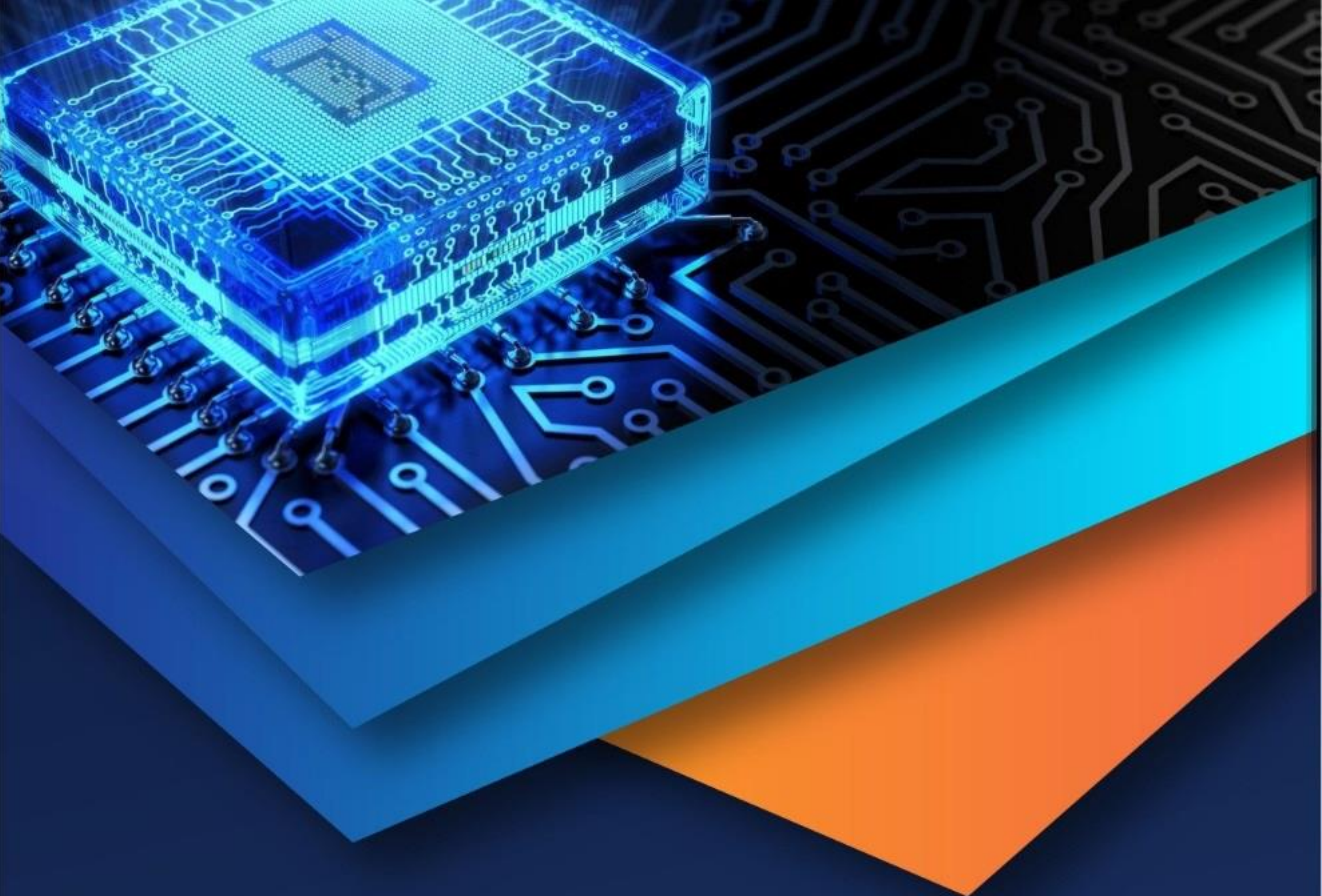
SabarishriK.,made an "Experimental Study on Strength Properties of High performance Concrete Using Copper Slag as a Partial Replacement of Fine Aggregate". The proportions of copper slag by weight of sand added to the concrete mixture is 0% (control mix), 30%, 40% and 50%. The target strength of control mix was 45N/mm2 by 28 days (M45 grade) with a water cement ratio of 0.42.The workability of concrete increases with increase in replacement of copper slag. The 28 days compressive strength of concrete mix increases up to 40% of replacement of copper slag and decreases for 50 % replacement of copper slag with fine aggregate. The flexural strength is more for all the proportions of concrete mix and this may be due to toughness of copper slag. The optimum amount of replacement of copper slag for fine aggregate in high performance concrete is 30- 40%.

III. NEED FOR THE STUDY

A. Cement is partially raplaced with GGBS, Metakaolin and RHA and fine aggregate with copper slag.
B. Cement is partially replaced with GGBS,silica fume and Rice Husk Ash and fine aggregates with copper slag.
C. Cement is partially replaced with GGBS,silica fume and Rice Husk Ash and fine aggregates with copper slag and marble powder
D. Cement is partially replaced with GGBS, Metakaolin and RHA and fine aggregate with copper slag and green sand.
E. Cement is partially replaced with GGBS, Metakaolin and RHA and fine aggregate with copper slag, green sand bottom ash.

IV. CONCLUSION

The study is to make use of industrial wastes such as 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%. Totally 19 number of mix ratios were taken.Concrete cubes 150 x 150 x 150 mm sizes of 3 no's were tested and there average values were used in the analysis using compression testing machine (CTM). Concrete cylinder of size 150mm dia x 300mm height sizes of 3 no's tested and there average values were used in the analysis using compression testing machine (CTM).Beam specimens of size 500mm x 100mm x 100 mm were used casted and tested to determine the modulus of rupture.The compressive strength, flexuralstrength, split tensile strength of test specimens was determined at the ages of 28, 56 and 90 days.



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