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A Research on Partial Replacement of Cement and Fine Aggregate by Alternatives for Eco Friendly Concrete

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Abstract: ***The objective of research proposal are to study the influence of percentage of copper slag as partial replacement of cement. The details scope of the study is, to investigate the artificial sand mixed concrete containing 5% , 10%, 15% and 20% of CS as partial replacement of cement and to evaluate the mechanical properties of concrete such as compressive strength, split tensile strength and flexural strength. This study has been carried out to analyse the efficiency of copper slag by replacing cement in the percentage of 0% (without copper slag), 5%, 10%, 15%, and 20% with 100% artificial sand . Six concrete mixes (C0, C5,C10, C15, C20 and natural concrete NC) were made by replacing cement with 5%, 10%, 15% and 20 % of copper slag by mass respectively. The water/cement ratio in all the mixes was kept at 0.45. As per global warming is concern, efforts are made toward reducing the emission of CO_2 in the environment. Cement industries are the major contributor in the emission of CO_2 as well as using high level energy resources in the production of cement. Researchers from all over the world are focusing on the way of utilising industrial waste, as supplementary cement replacement materials. This waste utilisation would not only be economical, but may also help protecting the environment.***

Keywords: Copper Slag, Artificial Sand, Compressive strength, Split Tensile Strength and Flexural Strength

I. INTRODUCTION

Concrete is a composite material composed of water coarse aggregate, Fine aggregate embedded in hard matrix of material. in the present scenario, as a result of continuous growth in population rapid industrialization and a accompanying technologies involving waste disposal, the rate discharge of pollutant into the atmosphere, copper slag is one of the industrial waste which comes out from the blast furnace during metal extraction process. the amount concrete used worldwide ,tone for tone, is twice that of the steel.wood,plastic and aluminium combined. When copper slag is introduced in the concrete as a replacement material it reduced, the environment pollution, space problem and also reduce cost of the concrete. Artificial aggregate is manufactured by crushing the by suitable boulders and rocks in crushing machine. As per environment concern are also being raised against uncontrolled extraction of natural sand. This the situation for the construction industry today and most will agree that it will not change dramatically in the foreseeable future.

Table-I: Sieve analysis of fine aggregates

SR No	Sieve no (mm)	Cumulative Weight retained (grams)	Cumulative percentage Retained (%)	Percentage passing (%)	Zone -II as per Is-383
1	4.75	14	1.4	98.6	90-100
2	2.36	80	8.0	92.0	75-100
3	1.18	322	32.2	67.8	55-90
4	600	518	51.8	48.2	35-59
5	300	720	72.0	28.0	8-30
6	150	947	94.7	5.3	0-10
7	Pan	1000			
			$\sum F$ = 260.1		

Table II: Physical properties of fine aggregates

SR No	Characteristics of fine aggregate	Value
1	Type	Natural and artificial sand
2	Specific gravity	2.60
3	Fineness modulus	2.60
4	Grading zone	Type-II
5	Water absorption	1.4%

Table III: Sieve analysis of natural coarse aggregates

SR No	Sieve no (mm)	Cumulative Weight retained (grams)	Cumulative percentage Retained (%)	Percentage passing (%)	Zone -II as per Is-383
1	40	0	0	100	100
2	20	44	1.47	98.53	95-100
3	10	1796	59.87	40.13	25-55
4	4.75	2835	94.5	5.5	0-10
5	Pan	3000	----------	----------	----------

Table IV: Properties of coarse aggregate

Size of aggregate	Specific Gravity	Water absorption	Fineness modulus	Flakiness index (%)	Elongation index (%)	Impact value (%)	Crushing value (%)
10(max.)	2.788	0.5	7.26	27	24	15.27	18

Table V: Physical properties of copper slag

Physical Properties	Copper Slag
Particle shape	Irregular
Appearance	Black & glassy
Type	Air cooled
Specific gravity	3.91,3.68
Percentage of voids	43.20%
Bulk density	2.08 g/cc, 1.70 to 1.90 g/cc
Particle size	0.075 mm to 4.75 mm
Hardness	Between 6 and 7

Table Vl: Chemical properties of copper slag

Chemical Component	Chemical Component (%)
SiO2	25.85
Fe2O3	68.29
Al2O3	0.22
CaO	0.15
Na2O	0.58
K2O	0.23
Mn2O3	0.22
TiO2	0.41

II. MATERIAL AND METHODOLGY

1) *Cement* - Portland –pozzolana cement of grade – 53 grade of ultra tech cement conforming to Indian standard IS 1489 -1991 part-I is used in this experimental work.
2) *Fine Aggregate* - The aggregate having size less than 4.75mm is known as fine aggregate. It can be obtain from bed rock. These fine aggregate should be free from any foreign matter, clay, silt and organic matter and should be hard and durable. It should confirm to IS 383-1970.
3) *Coarse Aggregate* - The aggregate having size more than 4.75mm then it is known as coarse aggregate. It is obtain from bed rock. It is available in different sizes and shape like rounded, irregular, or partly rounded, angular, flaky etc.It should be free from organic impurities and dirt content.
4) *Mix Design And Sample Preparation* - Concrete mixtures with different percentage of copper slag used as per partial replacement of cement and 100% replacement of artificial sand. These are prepared in order to investigate the effect of copper slag substitution on the strength normal concrete. Concrete mixtures were prepared with different percentage of copper slag. The proportions by weight of copper slag added to concrete mixtures were as 0%, 5%, 10%, 15% and 20%.

III.TESTING PROCEDURE

After curing the following result were carried out on the concrete sample.

A. Compressive strength was conducted on sample at 7 days, 14 days and 28 days of curing.
B. Split tensile strength was conducted on sample at 28 days of curing
C. Flexural strength was conducted on sample at 28 days of curing

IV.RESULTS AND DISCUSSIONS

Table VII: 7 days Compressive Strength investigation analysis

Sr. No.	Mix Type	Compressive strength (MPA)
1	P-100	16.43
2	CS-5-95	19.54
3	CS-10-90	19.85
4	CS-15-85	17.54
5	CS -20 - 80	13.20

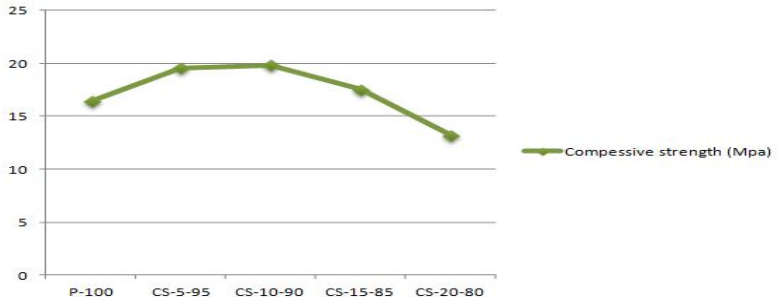


Table VII: 14 days Compressive Strength investigation analysis

Sr. No.	Mix Type	Compressive strength (MPA)
1	P-100	17.76
2	CS-5-95	21.75
3	CS-10-90	22.03
4	CS-15-85	18.92
5	CS -20 - 80	15.00

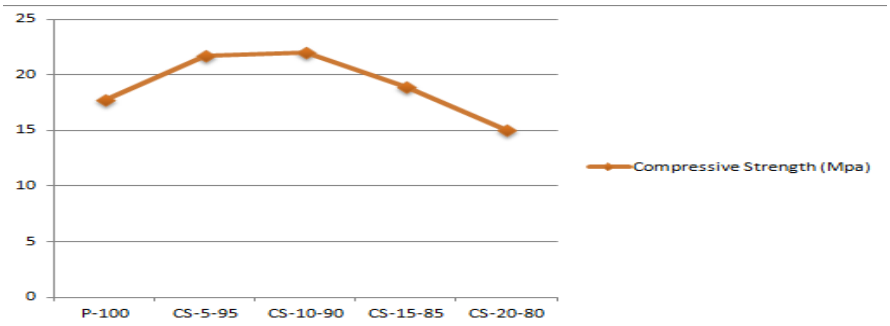
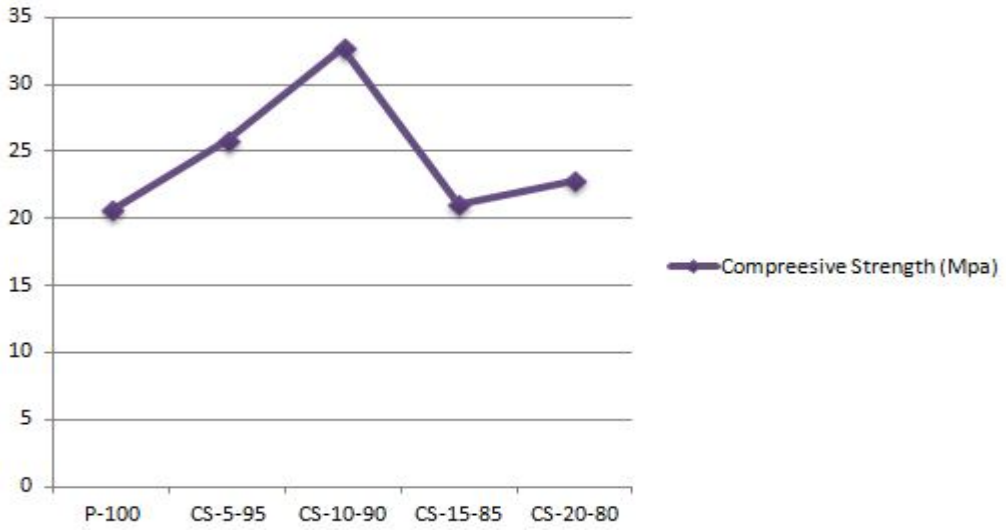


Table IX : 28 days Compressive Strength investigation analysis

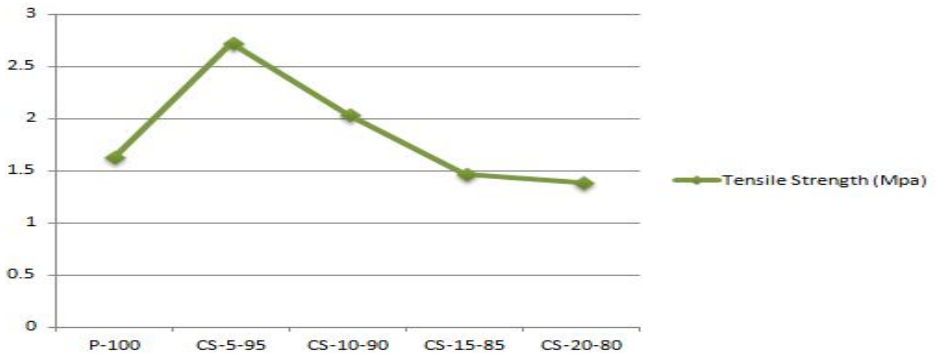
Sr. No.	Mix Type	Compressive strength (MPA)
1	P-100	20.58
2	CS-5-95	25.83
3	CS-10-90	32.67
4	CS-15-85	21.01
5	CS -20 - 80	22.75



From the test result it was observed that the compressive strength of concrete mixtures with replacement of fine aggregate with artificial sand and replacement of cement with copper slag was higher at 10% replacement of copper slag with 100% replacement of artificial sand which was found to be 19.85 Mpa for 7 days, 22.03Mpa for 14 days and 32.67 Mpa for 28 days.

Table X :28 Days Split Tensile Strength Test Reading

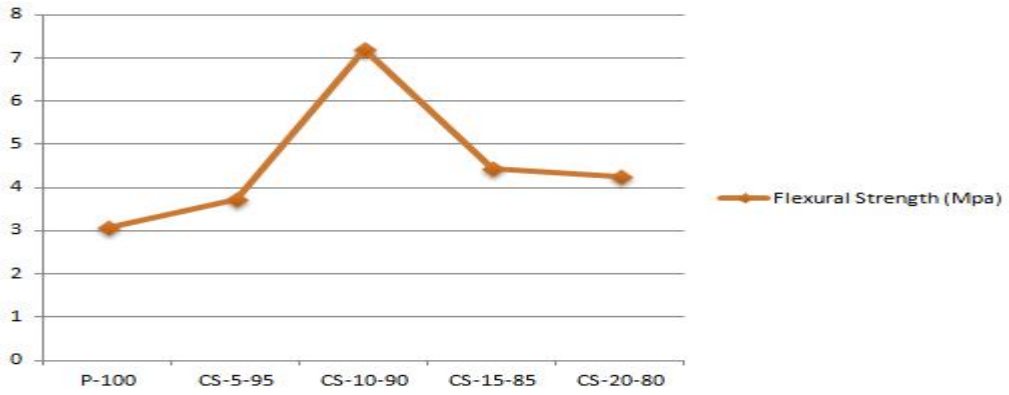
Sr No	Mix Type	Tensile strength (MPa)
1.	P-100	1.634
2.	CS-5-95	2.728
3.	CS-10-90	2.037
4.	CS-15-85	1.462
5.	CS -20 - 80	1.382



From the test result it was observed that the highest split tensile strength was achieved by 10% replacement of copper slag. Which was found to be 2.037Mpa for 28 days curing?

Table XI : 28 Days Flexure Strength Test Reading

Sr. NO	Mix Type (S.F. %)	Flexure strength (MPa)
1	P-100	3.07
2	CS-5-95	3.74
3	CS-10-90	7.21
4	CS-15-85	4.45
5	CS -20 - 80	4.25



From the test result it was observed that the highest flexural strength was achieved by 10% replacement of copper slag. Which was found to be 7.21Mpa for 28 days curing?

V. CONCLUSION

A. The replacement of fine aggregate using copper slag in concrete increase the density of concrete thereby increase the self weight of the concrete.

B. The utilization of copper slag in concrete provides additional environmental as well as technical benefits for all industries.

C. The compressive strength , split tensile strength and flexural strength of concrete with 10% addition of copper slag at 7 days,14days and 28 days was higher than design mixes (without replacement).

D. The recommended percentage replacement of cement by copper slag is 10% with 100% replacement of artificial sand.

E. By use of copper slag permeable voids are get reduced.

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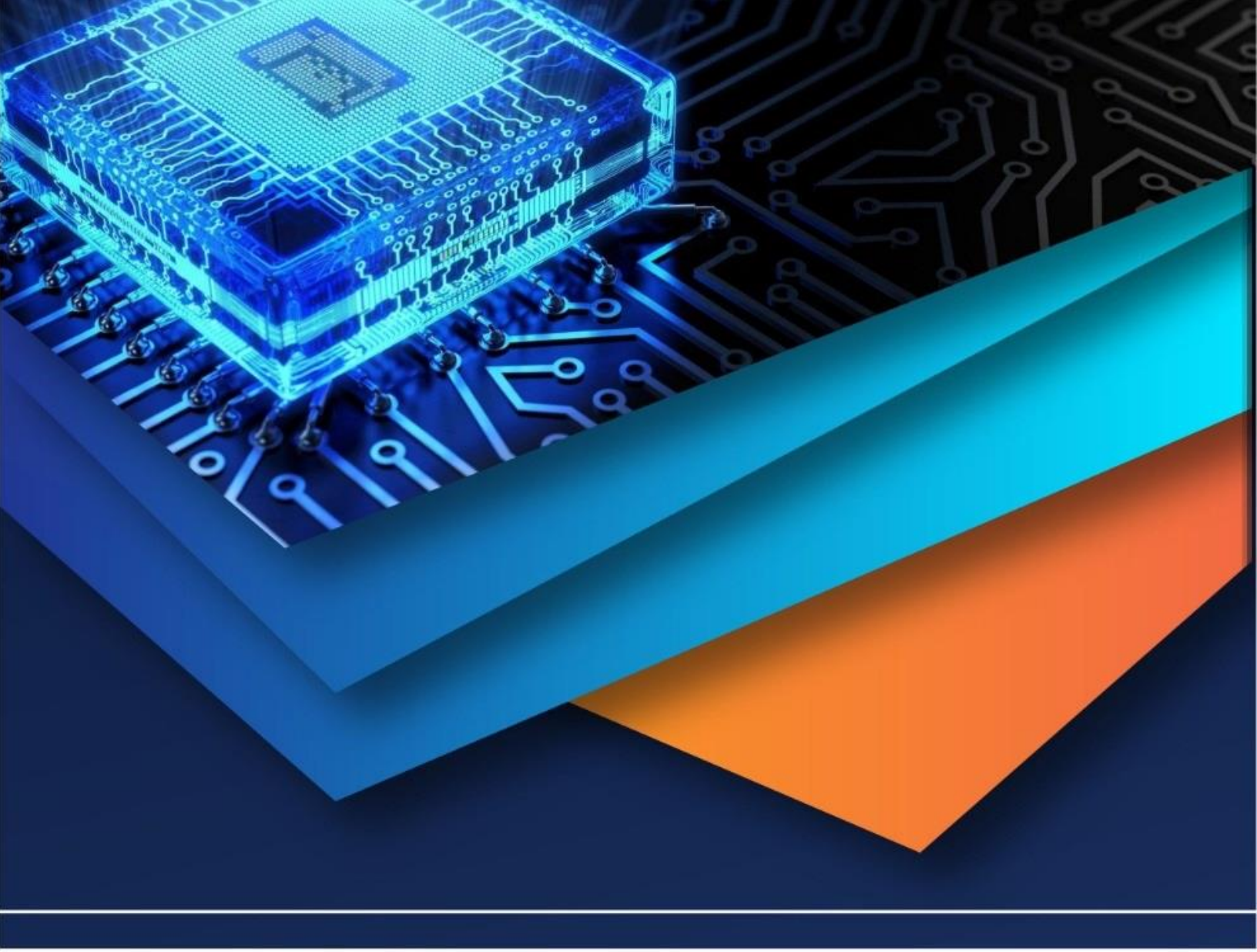

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