PROPERTIES OF CONCRETE FINE AGGREGATE PARTIALLY AND FULLY REPLACED WITH COPPER SLAG

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Abstract *Characteristic assets are draining worldwide while in the meantime the created squanders from the business are expanding generously. The manageable improvement for development includes the utilization of nonconventional and imaginative materials, and reusing of waste materials with a specific end goal to repay the absence of common assets and to discover elective ways saving nature. So test examination completed to assess the mechanical properties of solid blends in which fine aggregates (sand) was replaced with Copper Slag. The fine aggregates (sand) was replaced with rates 0% (for the ostensible blend), 10%, 20%, 30%, 40%, half, 60%, 80%, and 100% of Copper Slag by weight. Tests were performed for properties of new concrete and Hardened Concrete. Compressive strength and Flexural strength and sorptivity , RCPT ,were resolved at 7, 28 and 56days.*

The outcomes demonstrate that workability increments with expansion in Copper Slag rate. Test results demonstrate critical change in the quality properties of plain cement by the incorporation of up to 80% Copper slag as substitution of fine total (sand), and can be successfully utilized as a part of basic cement. Likewise as rate of Copper Slag expanded the thickness of cement expanded. The workability of cement expanded with expansion in rate of copper slag. Durability of copper slag is observed to be more, which expands the compressive and flexural strength of concrete.

keywords*: copper slag, compressive strength, sorpitivity, rapid chloride permeability test, water absorption test, concrete , partial replacement and so on…*

1. INTRODUCTION

Aggregates are viewed as one of the primary constituents of concrete since they possess more than 70% of the solid lattice. In numerous nations there is lack of common aggregates that are reasonable for development while in different nations there is an expansion in the utilization of aggregates because of the more prominent interest by the development business. With a specific end goal to diminish reliance on common aggregates as the fundamental wellspring of total in cement, falsely fabricated aggregates and simulated totals produced from mechanical squanders give another option to the development business. In this manner, use of totals from modern squanders can be contrasting option to the regular and fake aggregates. Without appropriate option totals being used sooner rather than later, the solid business all around will expend 8–12 billion tons every year of natural aggregates after the year 2010. Such huge utilization of characteristic aggregates will make pulverization the earth. The helpful utilization of by-products in solid innovation has been understood for a long time and noteworthy exploration has been distributed with respect to the utilization of materials, for example, coal fly fiery remains, pummeled fuel cinder, base powder, impact heater slag and silica rage as incomplete substitutions for Portland concrete or as fine aggregates.

2. EXPERIMENTAL INVESTIGATION

2.1 Materials

2.1.1 Cement

In this experimental investigation, Ordinary Portland Cement 53 grade, compliant to IS: 8112-1989 was used.

Physical properties	Results
Fineness	8%
Normal consistency	31.5%

Vicat initial setting time(minutes)	43mins
Vicat final setting time (minutes)	256min
Specific gravity	3.15
7-days compressive strength	39.65
28-days compressive strength	54.86

Tble.1:properties of cement

2.1.2 Aggregates

nearby obtainable natural sand with 4.75 mm maximum size confirm to class II- IS 383 was used as fine aggregate, have specific gravity, fineness modulus and unit weight as given in Table2 and compressed stone with 16mm maximum size have specific gravity, fineness modulus and unit weight as given in Table2 was used as coarse aggregate. Table 2 gives the physical properties of the coarse and fine aggregates.

Table 2: Physical Properties of CA and FA

Property	Fine Aggregate	Coarse Aggregate
Specific gravity	2.66	2.95
Fineness modulus	3.1	7.96
Surface texture	Smooth	--
Practical shape	rounded	angular

2.1.3 Water Ordinary potable water available in the laboratory has been used.

2.1.4 Copper slag

Copper slag is a by-item material created from the way toward assembling copper. As the copper settles down in the smelter, it has a higher thickness, pollutions stay in the top layer and after that are transported to a water bowl with a low temperature for hardening. The deciding item is a strong, hard

Fig.1: Grinded copper slag

IS sieve size in mm	Coarse aggregate Cumulative % retained	Fine aggregate Cumulative % retained	Copper slag Cumulative % retained
20.00	0.7	0.00	0.00
16.00	4.15	0.00	0.00
12.50	15.85	0.00	0.00
10.00	48.75	0.00	0.00
4.75	97.25	1.17	0.20
2.36	100	5.68	4.75
1.18	100	28.14	50.65
0.600	100	57.07	88.25
0.300	100	95.39	96.15
0.150	100	98.68	98.00
FM	**6.67**	**2.8**	**3.38**

Properties	Values
water absorption	**0.2 to 0.4 %**
Fineness modulus	**3.43**
Specific gravity	**4.05**
bulk density (gm/cc)	**2.20**

Table.3 Physical properties of Copper Slag

Table 3.1 Sieve Analysis of fine, Coarse Aggregate, and Copper Slag.

Table 3.2 M_{25} Mix proportions (Kg/m 3) and Mix ratio

Cement	Fine aggregate	Coarse aggregate	Water
384	636	683	192

3. TESTING PROCEDURES

This paper involved subjecting the composed cement blends to a progression of tests to assess the quality, and different properties. For this test, it was imperative to screen the quality improvement with time to enough assess the quality of every solid blend. For every test, 3 tests from every blend were tried at every curing age, and the normal qualities were utilized for examination. The accompanying segments introduce the methodology utilized for the different tests.

COMPRESSION TEST

A standout amongst the most imperative properties of cement is the estimation of its capacity to withstand compressive loads . This is alluded to as a compressive strength and is communicated as load per unit zone. One strategy for deciding the compressive quality of cement is to apply a heap at a consistent rate on a cube (150×150×150 mm), until the specimen comes up fail. The compression tests performed in this anticipate were finished as per IS standard 516 "Techniques for Tests for Strength of Concrete". The equipment used to decide the compressive strength of cements in this trial work was an all inclusive testing machine (UTM). For this study tests were tried for testing at 7, 28, 56 days of curing. The compressive strength of the solid as far as weight was then figured utilizing the Equation

$$f_c = P/A$$

Where,

fc = Compressive Strength of Concrete, (Kpa or psi)

P = Maximum load applied (KN or lb), and

A = The cross-sectional area of sample (mm^2 or in^2)

FLEXURAL STRENGTH TEST

Another essential quality property of cement is the flexural strength of a concrete. Tests were tried for flexural strength at 28 days of curing. The testing machine mechanical assembly used to quantify the flexural strength of cement in this exploratory work is worked by hydraulic pressure and has dial gage shows for observing the rate of load and the crest load on the example at the season of disappointment.. The flexural strength tests were performed when all is said in done agreement with IS standard 516 "Strategies for Tests for Strength of Concrete" Three point load involves subjecting a shaft test to a load condition which guarantees that no shear stresses in the center third of the example between the two point load focuses. The example encounters unadulterated bowing strengths in this district. To play out this test, every shaft was measured and set apart at the purposes of stacking to guarantee notwithstanding stacking on the specimen. Lines were drawn at 2.5, 17.5, 32.5, and 47.5 from one end, to help arrangement of the specimen in the correct position. The point load heads were cleaned and brought down onto the beginning position and all gages were focused. A static load was connected with a consistent rate until disappointment happened. The top load was acquired from the computerized show and recorded. The flexural strength was then ascertained utilizing Equation: $f_{cr} = Pl/bd^2$

Where,

f_{cr}= Flexural Strength of Concrete, (kpa or psi)

P = Maximum load applied (KN or lb),

l= Length of the specimen between the supports in (mm or in),

b = Width of the beam (mm or in), and

d = Depth of the beam (mm or in) .

SORPITIVITY

Test procedure

The sorptivity can be determined by the estimation of the cappilary ascent ingestion rate on sensibly homogeneous material. Water was utilized as the test liquid. The chambers in the wake of throwing were drenched in water for 28 days curing. The example size 100mm dia x 50 mm stature in the wake of drying in broiler at temperature of 100 + 10 °C were suffocated with water level not more than 5 mm above. The sample to be oven dried for 3 days and weight is measured. After 3days of oven dried sample ought to be set in a one side opened spread for 15 days after 15days the base of sample and the flow from the fringe surface is anticipated via fixing it appropriately with non-retentive covering. The amount of water consumed in day and age of 30 minutes was measured by weighting the sample on a top pan balance upto 0.1 mg. surface water on the example was wiped off with a hosed tissue and every weighting operation was finished inside 30 seconds. Sorptivity (S) is a material property which portrays the propensity of a permeable material to assimilate and transmit water by capillarity. The cumulative water absorption (per unit area of the inflow surface) increases as the square root of elapsed time (t).

Fig No.2 Specimen placed in water

The cumulative water absorption (per unit area of the inflow surface) increases as the square root of elapsed time (t) $I=S.t^{½}$

Therefore

$S=I/ t^{½}$

Where;

S= sorptivity in mm,

t= elapsed time in mint.

$I=\Delta w/Ad$

Δw= change in weight = W2-W1

W1 = Oven dry weight of cylinder in grams

W2 = Weight of cylinder after30 minutes capillary suction of water in grams.

A= surface area of the specimen through which water penetrated.

d= density of water

RAPID CHLORIDE PERMEABLITY TEST

Test Procedure (ASTM C 1202)

Rapid chloride permeability test According to ASTM C1202 test, water-saturated, 50 mm thick, 100 mm thick diameter concrete specimen is subjected to applied DC voltage of 60 V for 6 hours .In one container 3.0% NaC1 solution and in the other container 0.3 M NaOH solution. The durability of fiber reinforced concrete that is resistance to chloride penetration is studied. Rapid chloride ion penetrability tests were for copper slag specimens, an electrical current recorded at 1 minute intervals over the 6 hour time, resulting in the total charge passed in coulombs is shown in Table 7 and Table 4 shows chloride permeability as per ASTM C 1202. The testing of specimens were done at 28days RCPT values for mix proportion.

Table No.4 RCPT ratings as per ASTM C1202.

Charge Passing (Coulombs)	**Charge Passing (Coulombs)**
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very Low
<100	Negligible

WATER ABSORPTION TEST

The 100mm dia x 50 mm height cylinder after casting were immersed in water for 28 days curing. These specimens were then oven dried for 24 hours at the temperature110°C until the mass became constant and again weighed. This weight was noted as the dry weight (W1) of the cylinder. After that the specimen was kept in hot water at 85°c for 3.5 hours. Then this weight was noted as the wet weight (W2) of the cylinder.
% water absorption = [(W2– W1) / W1] x 100
Where,
W1 = Oven dry weight of cylinder in grams
W2 = After 3.5 hours wet weight of cylinder in grams.

4. TESTS AND RESULTS

The different tests conducted in laboratories .It consist mixing of concrete in the laboratory by replacing Copper Slag as fine aggregate with proportions (by weight) of Copper Slag added to concrete mixtures were as follows: 0% (for the control mix), 10%, 20%, 30%, 40%, 50%, 60%, 80%, and 100%. Concrete samples were prepared and cured in the laboratory, and are tested, to evaluate the concrete fresh and harden properties like workability of concrete, compressive strength and flexural strength requirements.

MECHANICAL PROPERTIES

Compressive Strength

Compression tests were performed on samples made during at various curing ages. As discussed earlier, a targeted compressive strength was used for this investigation. Results from compression strength tests performed are presented in this section. Cube samples of size 150 x 150 x 150 mm, were prepared and tested at 7, 28, and 56-days of curing in water under controlled laboratory conditions. 3 samples were tested at each curing age. Tables 5 show the average compressive strengths of the concretes tested.

TableNo.5 Compressive strengths test results(Mpa)

Flexural Strength

Not less than 3 samples were tried at every curing age. The normal flexural strength of the solid composites measured amid this period of the analysis are introduced in Table 6.

TableNo.6 Flexural Strengths of Concrete at 28 days(Mpa)

Mix	7days	28days	56days
NORMAL	27.56	37.78	37.84
CS 10 %	30.73	40.97	39.10
CS 20 %	36.33	48.13	49.37
CS 30 %	33.27	40.83	45.47
CS 40 %	28.43	38.80	44.43
CS 50 %	28.87	39.43	44.90
CS 60 %	29.53	43.33	45.17
CS 80 %	28.01	35.17	38.43
CS 100 %	22.30	32.07	35.70

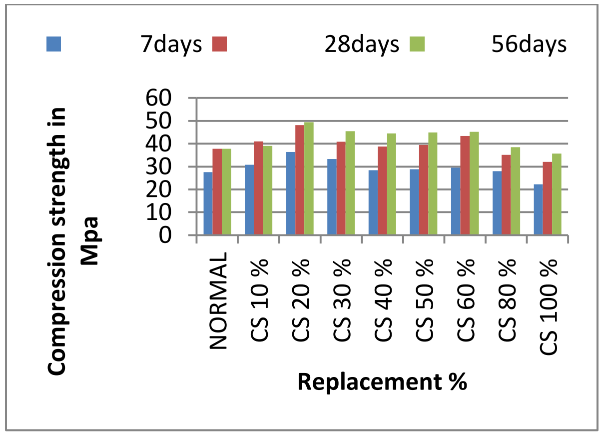

Chart No.1 Compression strength results

MIX PROPORTIONS	FLEXTURE STRENGTH(Mpa)
CS10%	4.26
CS20%	4.32
CS30%	4.56
CS40%	4.22
CS50%	4.12
CS60%	4.33
CS70%	4.84
CS80%	4.41
CS90%	4.27
CS100%	4.11

Specimen Designation	Sorptivity Value (x 10^{-6}) mm/ min $^{0.5}$	Absorption Rate I = S.t ½ mm
CS10%s	4.50	101.62
CS20%	4.60	100.14
CS30%	5.36	111.23
CS40%	4.55	104.2
CS50%	6.28	125.6
CS60%	6.94	134.01
CS70%	8.23	141.03
CS80%	7.12	139.2
CS90%	8.66	154.17
CS100%	9.23	174.23

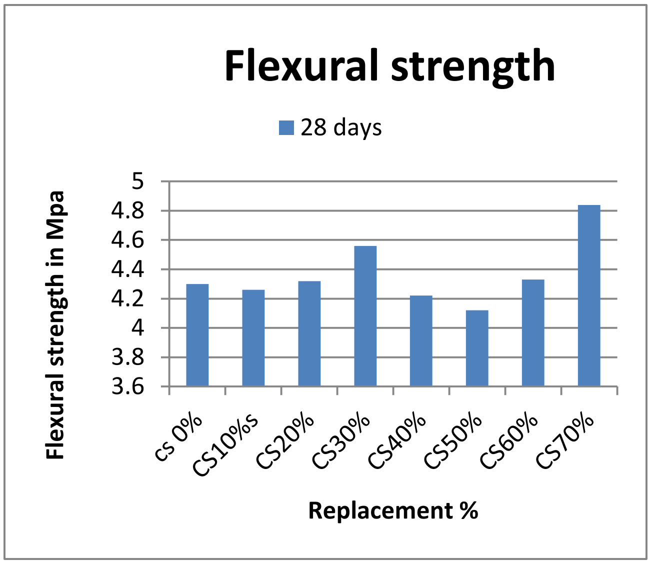

Chart No .2 Flexural strength results

DURABLE PROPERTIES

RAPID CHLORIDE PERMEABILITY TEST

The test outcomes ought to be comprehended that higher the charge coulomb passed higher is the chloride particle infiltration in this way lower is the strength of the sample. The outcomes as appeared in Table 7 affirm that however every one of the examples are inside the Moderate Durability according to ASTM C 120212. The lowest charge passed was in case of CS30% indicating highest durability.

Table No.7 RCPT Results at 28 days

Specimen Designation	Charge Passed Through In Coloumbs (C)	Chloride Permeability Results As Per ASTM C 1202
CS10%s	2908	MODERATE
CS20%	2212	MODERATE
CS30%	2011	MODERATE
CS40%	2564	MODERATE
CS50%	3645	MODERATE
CS60%	3541	MODERATE
CS70%	2254	MODERATE
CS80%	3362	MODERATE
CS90%	3331	MODERATE
CS100%	2145	MODERATE

SORPTIVITY

Sorptivity implies the passing of water through the impact of capillarity in cement. High sorptivity demonstrates higher permeability of concrete.

Table No.8 Sorpitivity and water absorption Results at 28days

5.CONCLUSIONS

1) Greatest Compressive strength of concrete for a substitution of fine total by 20% of copper slag expanded by 34% at 7 days and expanded by 29% at 28 days. Comparable expansion is seen at 56 days strength.

2) Replacement of copper slag up to 80% will expand the strength of design mix ,after that80% substitution the strength began to lessen. The strength at 100 % substitution is decreased by 7% at 28 days.
3) It is watched that, the flexural strength of concrete at 28 days is higher than configuration design mix (Without substitution) for 20% substitution of fine total by Copper slag, the flexural strength of concrete is expanded by 14%. This likewise shows flexural strength is more for all rate substitutions than configuration design mix.
4) Compressive strength and Flexural strength was expanded because of the high sturdiness property of Copper slag.
5) Chloride penetrability of the solid saw as moderate.

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