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Experimental Analysis on High Strength Concrete Replacement of Fine Aggregate Using Copper Slag

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Abstract - *Copper slag is an industrial by-product, produced during manufacture of copper. Due to depletion & thereby scarcity of natural resources seems to be a problem for successive generations, it is needed to search the alternatives of natural sand (river sand). This study aims to understand the results and comparison between the properties of high strength concrete & concrete made by partial replacement of river sand by copper slag. For this research M-55 grade of concrete will used. And the replacement of natural sand by copper slag by various percentages will be analyzed. Scope of this study is limited to the Mechanical Properties of high strength concrete.*

Key Words: **Cement, Copper Slag, High Strength Concrete, Acid Attack, ACI.**

1. INTRODUCTION

In India, there is extraordinary request of totals primarily from structural building industry for street and solid developments. Be that as it may, these days it is an extremely troublesome issue for accessibility of fine totals. So the analysts created squander administration systems to apply for substitution of fine totals for particular needs. Common asset are exhausting worldwide while in the meantime the produced squanders from the business are expanding generously. The practical improvement for development includes the utilization of nonconventional and creative materials, and reusing of waste materials so as to remunerate the absence of normal assets and to discover elective ways rationing the-earth. The quick increment in the regular totals utilization consistently because of the expansion in the development business overall implies that the totals holds are being exhausted quickly, especially in forsake nations. It has gone as far as anyone is concerned that, without legitimate elective totals being used soon, the solid ventures internationally devour 8-10 billion tons of normal totals, after a few years that will be renewed.

Copper slag is one of the materials that are considered as a waste material which could have a promising future in the development business as fractional or full substitute of either concrete or totals. It is a result acquired amid the matte purifying and refining of copper. To create each ton of copper, around 2.2-3.0 tons copper slag is created as a side-effect material. In India copper slag is delivered by numerous enterprises one of them is Sterlite Industries Ltd (SIL), Tuticorin Tamil Nadu. It is delivering Copper slag amid the fabricate of copper metal. Right now, around 2600 tons of Copper slag are created every day and an aggregate gathering of around 1.5 million tons. In the event that we can utilize the copper slag set up of normal sand, at that point we can progressively get a material to supplant the sand, which is eco-accommodating and savvy. Consequently there is a developing need to locate the elective answer for the slag administration.

2. OBJECTIVE

To evaluate optimum dosage as a substitute for copper slag the fine aggregate in proportion of 0%、20%、30%、40% by weight to enhance the mechanical properties(Compressive Strength, Flexural Strength, Split Tensile) & Durability(Acid Attack) of high strength concrete.

3. MATERIAL

3.1 Cement

An OPC 43 Grade Ramco cement was used in this investigation. The amount I evaluated what I needed for this work and bought the whole amount and stored right in the casting yard. The following examinations were taken According to IS codes: Specific gravity (Le: Chatelier flask) (IS: 1727-1967) Standard consistency (IS: 4031 - 1988 Part 4) Initial setting time (IS: 4031 - 1988 Part 5) Final setting time (IS: 4031 – 1988 Part 5).

3.2 Water

The water used for mixing and curing shall be clean free from harmful amounts of salt, oil, acid, alkali, organic matter or other harmful substances

3.3 Fine Aggregate

Fine aggregate (sand) used for investigation is clean river sand conforming to zone II according to IS: 383-2016. The sand was first sieved with a 4.75 mm sieve and particles larger than 4.75 mm were removed.

3.4 Coarse Aggregate

The use of coarse aggregate as crushed aggregate used passes through a 20 mm IS sieve and is retained from the 4.75 mm IS sieve.

3.5 Copper Slag

Copper Slag is use as the replacement of natural fine aggregate (sand). Specific gravity of Copper Slag is 3.47 used in this research work.

Table -1: Chemical Composition of Copper Slag

S.No	Chemical Component	% of chemical component
1.	SiO2	70.19
2.	Fe2O3	12.99
3.	Al2O3	0.79
4.	CaO	1.88
5.	MgO	0.23

4. EXPERIMENTAL PLAN

4.1 Test Procedure

A. Assessment of mix design methods.

B. Selection of mixing procedures and test methods.

C. Selection of the target properties of concrete containing copper slag for the subsequent tests.

D. Selection of constituent materials.

4.2 Mix Proportions

The fine aggregate is replaced by Copper Slag from (0%, 20%, 30%, 40%, and 50%). Test was carried out for M-55 grade concrete.

5. RESULT & DISCUSSIONS

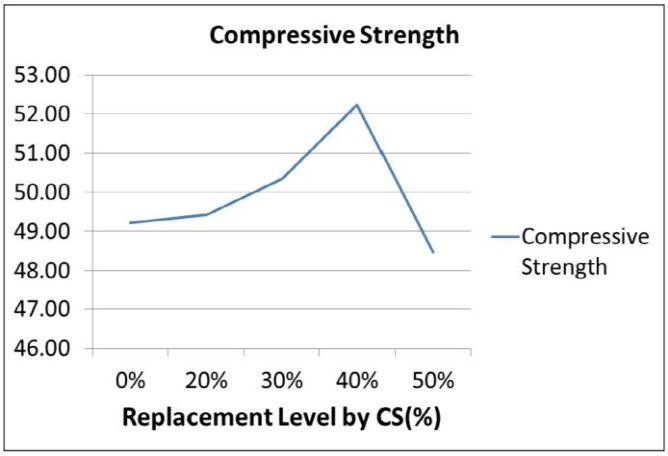
5.1 Hardened Concrete Result

A. Compressive Strength Test

In M-55 grade of concrete the value of 40% CS replacement gives maximum 69.64 MPA compressive strength. Replacement data given as per below

Table -2: Compressive Strength of Cube for M-55 Grade Concrete

SR. NO.	TYPE OF MIX	COMPRESSIVE STRENGTH @ 7 DAYS	COMPRESSIVE STRENGTH @ 28 DAYS
1	00%CS+ 100% F.A.	49.22	64.63
2	20%CS+ 80% F.A.	49.42	65.89
3	30%CS+ 70% F.A.	50.35	67.13
4	40%CS+ 60% F.A.	52.23	69.64
5	50%CS+ 50% F.A.	48.47	64.62



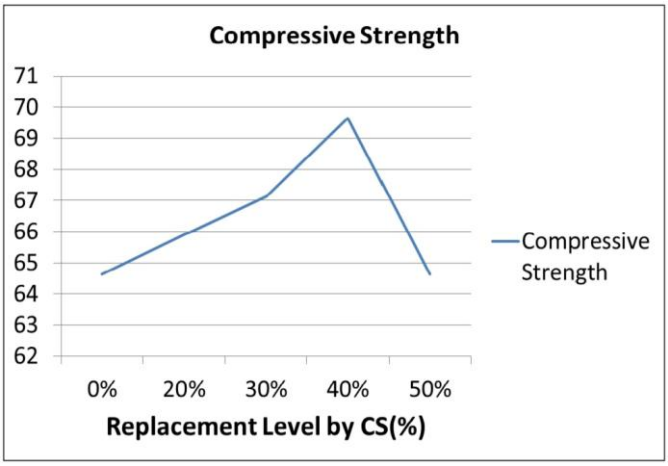


Chart -1 & 2: Compressive Strength of Cube for M-55 Grade Concrete @ 7 days & 28 days (max. valve of each %)

B. Flexural Strength Results

In M-55 grade of concrete the value of flexural strength change with respect to the % CS replacement increase. The CS 40% replacement value gives optimum value of the flexural strength. The flexural strength is decrease in 40% to

50% replacement. The value of flexural strength is shown as per given below table

Table -3: Flexural Strength of M-55 Grade Concrete

SR. NO.	TYPE OF MIX	FLEXURAL STRENGTH @ 28 DAYS
1	00%CS+ 100% F.A.	5.78
2	20%CS+ 80% F.A.	5.88
3	30%CS+ 70% F.A.	5.99
4	40%CS+ 60% F.A.	6.22
5	50%CS+ 50% F.A.	5.77

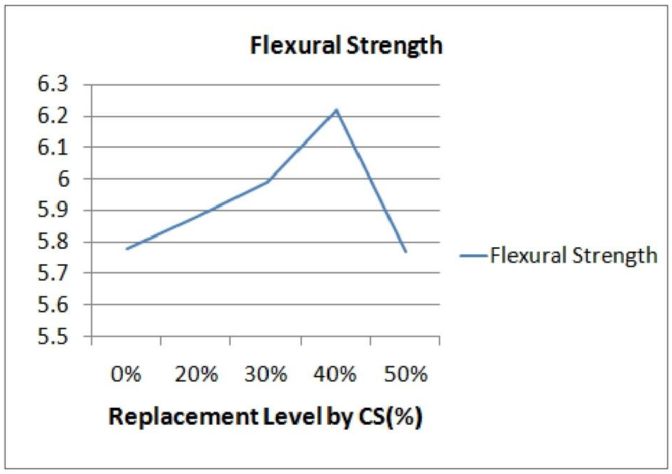


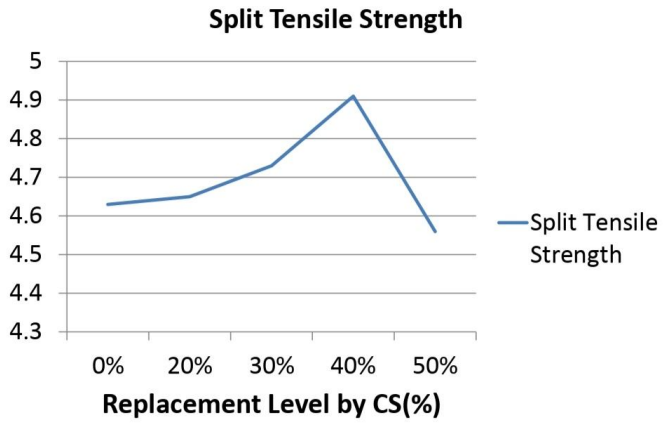
Chart -3: Flexural Strength of Cube for M-55 Grade Concrete @28 days (max. valve of each %)

B. Split Tensile Strength Results

In M-55 grade of concrete the value of split tensile strength change with respect to the % CS replacement increase. The CS 40% replacement value gives optimum value of the flexural strength. The flexural strength is decrease in fully replacement

Table -4: Split Tensile Strength of M-55 Grade Concrete

SR. NO.	TYPE OF MIX	SPLIT TENSILE STRENGTH @ 7 DAYS	SPLIT TENSILE @ 28 DAYS
1	00%CS+ 100% F.A.	4.63	6.08
2	20%CS+ 80% F.A.	4.65	6.19
3	30%CS+ 70% F.A.	4.73	6.31
4	40%CS+ 60% F.A.	4.91	6.55
5	50%CS+ 50% F.A.	4.56	6.07



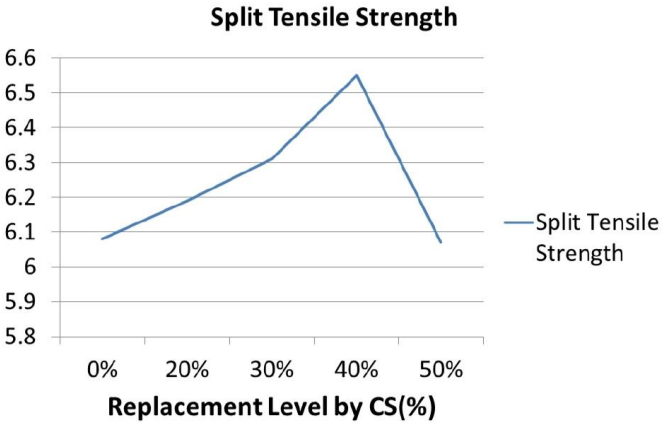


Chart -4 & 5: Split Tensile Strength of Cube for M-55 Grade Concrete @ 7 days & 28 days (max. valve of each %)

5.1 Durability Test Result

A. Acid Attack Test Result

In the acid attack test the compressive strength of concrete is measured after 35 days & 56 days of curing (28 days of normal water curing and 07 days & 28 days of curing in 5% H2S04l·The all value of replacement 00%, 20%, 30%, 40%, 50% found to be increased compare to the 0% replacement of CS up to 40% then it decreased. Hence from that we say that optimum content of the CS is 40%.

Table -5: Acid Attack Test Results for M-55 Grade @35days & 56 Days

SR. NO.	TYPE OF MIX	COMPRESSIVE STRENGTH @ 7 DAYS	COMPRESSIVE STRENGTH @ 28 DAYS
1	00%CS+ 100% F.A.	42.12	55.31
2	20%CS+ 80% F.A.	42.29	56.39
3	30%CS+ 70% F.A.	43.09	57.45

4	40%CS+ 60% F.A.	44.70	59.6
5	50%CS+ 50% F.A.	41.48	55.30

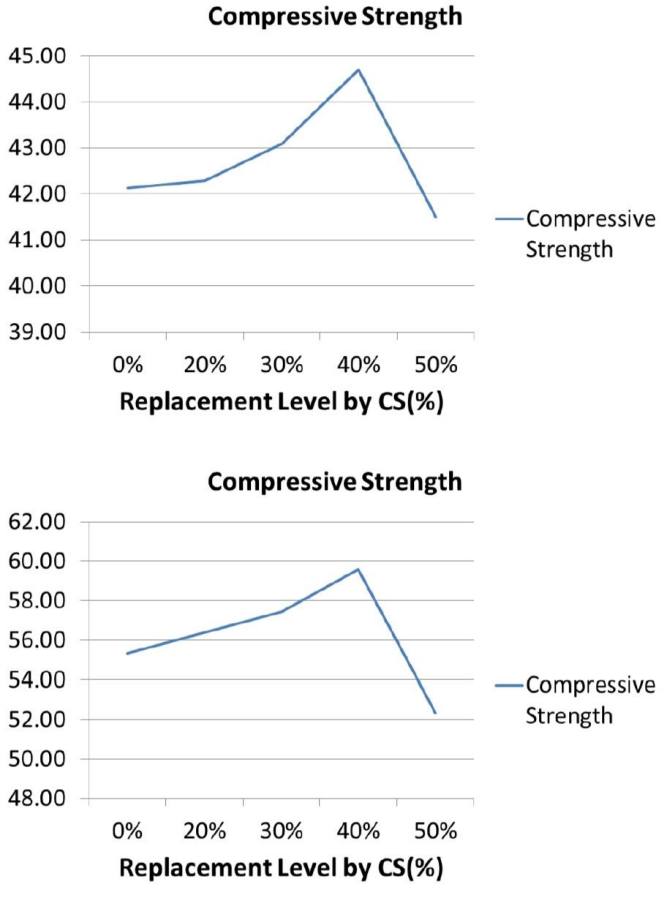


Chart -6 & 7: Acid Attack Test Result for M-55 Grade Concrete @ 35 days & 56 days (max. valve of each %)

6. CONCLUSIONS

Based on experimental investigation, following observations are made on the fresh property, hardened properties and durability of concrete containing copper slag:

The study attains the highest possible strength of Copper Slag. The results shows that 40% Replacement of natural fine aggregate by the Copper Slag was found be good performance in compressive strength, spilt tensile strength, and flexure strength.

The 40% replacement of fine aggregate by Copper Slag is optimum value content of all replacements: Such as: compressive strength, spilt tensile strength, flexural Strength.

In an acid attack test (5% H2S04) of Durability all replacements shows higher value than the normal mix (0% CS).

The 40% replacement of fine aggregate by Copper Slag is optimum value content of the acid attack test.

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