# Strength Characteristics of M25 Grade Concrete by Partially Replacing Cement with Rice Husk Ash and Fine Aggregate with Copper Slag

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*Abstract*— Concrete is a highly demanded construction material which is used in construction industries which becomes present days high expensive due to the corresponding increase in the demand in construction among which lesser availability of sand is major concern hence there is a need to find alternate for sand. Copper slag is one of the waste material which can be replaced by sand available free of cost thus the cost of construction can be lowered. In this project work cement is partially replaced with Rice Husk Ash as 15% fixed by weight of cement & fine aggregate is partially replaced with copper slag as percentage ranging 0%, 10%, 20%, 30% & 40% by weight of sand for M25 grade concrete. And tests conducted on hardened concrete is compressive strength test, split tensile test , flexural strength test and sorptivity test after specimens are cured for 7, 28 days curing. The effect of Rice Husk Ash and Copper Slag on mechanical properties of concrete were analyzed and compared with normal concrete. In comparison with normal concrete, the compressive strength after 28days is increased in 8.27% for 30%. The split tensile strength after 28days is increased in 32.09% for 30%. The flexural strength for 28days is increased as 15.29% for 30%. And by the sorptivity test is found that, as the percentage of copper slag increases then there will be decrease in water absorption.

***Key words:*** M25 Grade Concrete, Rice Husk Ash, Fine Aggregate with Copper Slag

## I. INTRODUCTION

There are lots of materials that are used in the construction industry such as, concrete, brick, mud, steel, wood, concrete, glass and so on, but cement concrete remains the main material in the construction industries. The strength characteristics and the structural stability of the concrete, which makes the most largely used element in the construction industry for making foundation, architectural structures, bridges, dams, parking structures, highways, runways, poles, runways etc.

On the other hand human activities are generating industrial residue and agricultural approximately 2500MT per year. To management wastes has become severe problem in the world. So researches has developed waste management techniques or strategies to reduce such problems and use of that waste material in conventional concrete. So researchers from recent studies has concluded that the waste material either organic or in-organic which produces many by-product can be utilized in concrete.

## II. MATERIALS USED

### A. Cement

Chettinad OPC 53 grade cement is used in this work conforming to [IS-12269-1987]. Physical property of Cement is shown.

| Physical property | Cement |
|---|---|
| Fineness | 5% |
| Sp. gravity | 03.14 |
| Normal consistency | 32.0% |
| Initial Setting Time | 30 Minute |
| Final Setting Time | 480 Minute |

Table 1: Cement Physical property.

### B. Fine Aggregate

In this work sand was taken from Gulbarga district conforming to IS 383-1970 was found under zone II

| Physical properties | River sand |
|---|---|
| Specific gravity | 2.60 |
| Bulk density (kg/m$^3$) | 1633.3 |
| Fineness modulus | 3.10 |
| Water absorption (%) | 2.0 |

Table 2: Physical Properties of Fine Aggregate

### C. Coarse Aggregate

In this work aggregates 20mm down which is having irregular shape is utilized and basic tests was carried out.

| Physical properties | Coarse Aggregate |
|---|---|
| Specific gravity | 3.07 |
| Bulk density (kg/m$^3$) | 2089.6 |
| Water absorption (%) | 1.06 |

Table 3: Physical Properties of Coarse Aggregate

### D. Copper Slag

It is a byproduct of copper industry which produced during copper extraction by smelting. The C.S was brought from Hindalco Industries Ltd. Ahmedabad.

| Physical property | Copper slag |
|---|---|
| Sp. gravity | 3.07 |
| Bulk density (kg/m$^3$) | 2089.6 |
| Water absorption (%) | 0.36 |

Table 4: Physical Properties of Copper Slag Obtained

Fig. 1: Copper Slag

 

*E. Rice Husk Ash*

It is an agricultural byproduct produced by the firing of rice husks in steam boilers. In this work rice husk ash bought from Chudi Rice Mill Raichur district.

| Physical property | R.H.A |
|---|---|
| Specific gravity | 2.28 |
| Specific surface area ($m^2$/gm) | 36.47 |

Table 5: Physical Property of Rice Husk Ash

Fig. 2: Rice Husk Ash Used

*F. Water*

Water required in mixing the concrete also for curing of specimens, it should not contain hazardous materials. In this investigation potable water is used.

*G. Super plasticizers*

In this work Conplast SP430 Superplasticizer is used. The dosage of super plasticizers is 1.5% by weight of cementitious materials

*H. Mix Design*

The mix design forM25grade concrete is designed in accordance with IS 10262-2009.

| Water | Cement | Fine Aggregate | Coarse Aggregate |
|---|---|---|---|
| 167.45 | 409.32 | 650.37 | 1199.13 |
| 0.41 | 1 | 1.58 | 2.92 |

Table 6: Mix Proportion (kg/$m^3$), Mix Ratio of M25 Grade Concrete.

## III. RESULTS AND DISCUSSION

*A. Tests on Fresh Concrete*

*1) Slump Cone Test*

The slump values for different mix proportions are shows in the table below.

*2) Compaction Factor Test*

This test is used to find workability of fresh concrete as per *(IS¯1199–1959).*

| MIX I.D | Slump (mm) | Compaction factor |
|---|---|---|
| M0 | 71 | 0.91 |
| M1 | 42 | 0.81 |
| M2 | 49 | 0.83 |
| M3 | 58 | 0.87 |
| M4 | 66 | 0.89 |

Table 7: Results of Slump Cone and Compaction Factor Test

*B. Tests on Hardened Concrete*

In this project work four tests is done for different mixes namely, Compressive Strength, Split Tensile, and Flexural Strength &Sorptivity Test for various mixes as shown in below.

| MIX I.D | Percentage of Copper Slag (%) | Percentage Of Rice Husk Ash (%) |
|---|---|---|
| M0 | 0 | 0 |
| M1 | 10 | 15 |
| M2 | 20 | 15 |
| M3 | 30 | 15 |
| M4 | 40 | 15 |

Table 8: Different Mix Proportion

*1) Compressive Strength*

This test is carried out to find the compressive strength of concrete which is the important properties of the concrete. to determine compressive strength of concrete, concrete cubes of dimension 150mmx150mmx150mm is casted and after 7 days &28 days curing the cubes was tested to get the compressive strength of various mixes. The formula to find Compressive strength is load at which specimen fail by area of the specimen.

$$Fc = \left\{\frac{P}{A} N/mm2\right\}$$

$F_c$= Compressive strength ($N/mm^{2)}$

P = force at which specimen break (N)

A = cube Cross sectional area in ($mm^2$)

| Mix ID | Compressive Strength($N/mm^2$) | |
|---|---|---|
| | 7days | 28days |
| M0 | 21.92 | 33.70 |
| M1 | 23.19 | 34.26 |
| M2 | 25.48 | 35.11 |
| M3 | 26.73 | 36.74 |
| M4 | 24.66 | 34.53 |

Table 9: Average Compressive Strength.

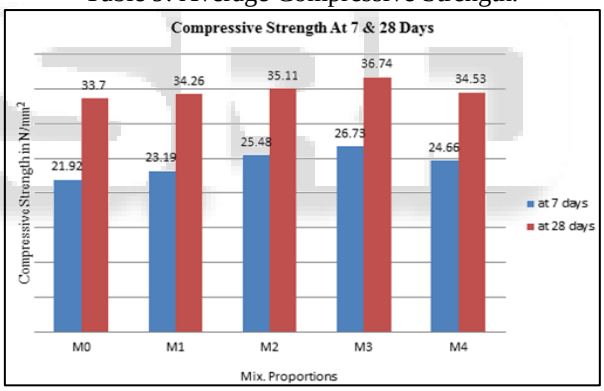


Fig. 3: Average Compressive Strength at 7 & 28 days

Fig. 4: Failure Pattern

*2) Split Tensile Strength (IS-5816-1970)*

Tensile strength test is carried out to find the tensile strength of concrete which is the important property of the concrete. The information of tensile value is very much needed for design the concrete structural member which is subjected to torsion, shrinkage, and temperature effects etc. The specimens of size 150mm dia& 300mm height is tested after cured for 7 days and 28 days.

 

Split. Tensile Strength = $\frac{2P}{\pi DL}$

P = Applied force *N*.
L = Specimen Length mm.
D = Specimen diameter mm.

| Mix ID | Split Tensile Strength(N/mm$^2$) | |
|---|---|---|
| | 7days | 28days |
| M0 | 2.06 | 2.75 |
| M1 | 2.14 | 3.18 |
| M2 | 2.28 | 3.46 |
| M3 | 2.58 | 4.05 |
| M4 | 2.44 | 3.84 |

Table 10: Average Split Tensile Strength

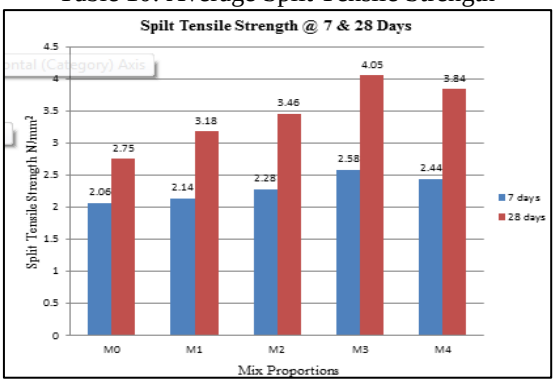


Fig. 5: Average Split Tensile Strength at 7& 28 days

Fig. 6: Failure Pattern of Cylinder

*3) Flexural Strength Test (IS¯516-1959):*

This test is used to find the flexural strength of concrete in accordance IS 516-1959.

Flexural strength is calculated by,

Flexural strength $F_b = \frac{pl}{bd2}$

$F_b$ = flexural strength *N/mm$^2$*
P = load *N*
L= prism length *mm*
B = prism width *mm*
D = depth in, mm

| Mix ID | Flexural Strength(N/mm$^2$) | |
|---|---|---|
| | 7days | 28days |
| M0 | 4.10 | 5.87 |
| M1 | 4.46 | 6.11 |
| M2 | 4.71 | 6.46 |
| M3 | 4.96 | 6.93 |
| M4 | 4.50 | 6.82 |

Table 11: Flexural Strength.

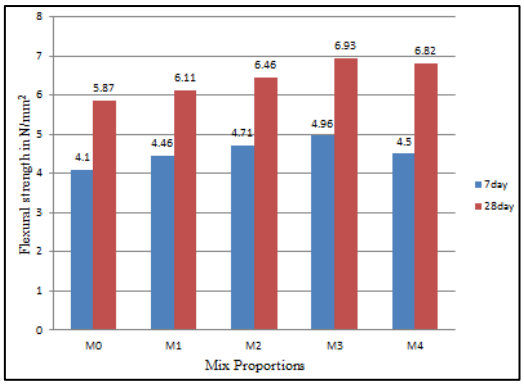


Fig. 7: Average Split Tensile Strength at 7&28 days

Fig. 8: Failure Pattern of prism

*4) Sorptivity Test*

Sorptivity test is used to the determine the sorptivity, which is calculated by measuring the capillarity rise absorption rate on reasonable homogeneous material. In this test water was taken as Test fluid. The cylindrical disc of size 100mm diameter & 50mm ht. is casted and then after 24 hrdemoulded and immersed in curing tank for 28days. After 28 days cylinders are kept in oven for drying @ a temperature of {100+10$^o$C} and it was submersed with level (not > 5mm) above the base of cylinder. Then flow by the peripheral Surface was sealed by Non-Absorbent coating. The amount of water which get absorb in 30 minutes was weighting on the weighing machine. The surface area of specimen was wiped off with a tissue paper and weight of the each specimens was taken within 30 sec.

Sorption (S) is a material property that is characterized by a tendency a porous material for absorption and transfer of water through capillaries. Cumulative water Absorption (Unit area at the entrance) increases as the square root of the flow Time (t).

$$S=I/t^{1/2}$$

S= Sorptivity
T= Time elapsed Minutes.

$$I=\Delta W/Ad$$

ΔW = changes in weight=W2-W1
W1=dry weight of cylinder in oven in mm
W2= cylinder Weight 30 minutes after capillary suction of water gm.
A= Surface area of the cylinder from where water is penetrated.
d= water density.

| MIX ID | Dry weight in (gm) | Weight in (gm) | Sorptivity x $10^{-6}$ ($m/s^{1/2}$) |
|---|---|---|---|
| M0 | 927 | 938 | 14.56 |
| M1 | 932 | 942 | 13.64 |
| M2 | 928 | 935 | 11.34 |
| M3 | 932 | 940 | 10.89 |
| M4 | 929 | 935 | 8.13 |

Table 12: Sorptivity Results

 

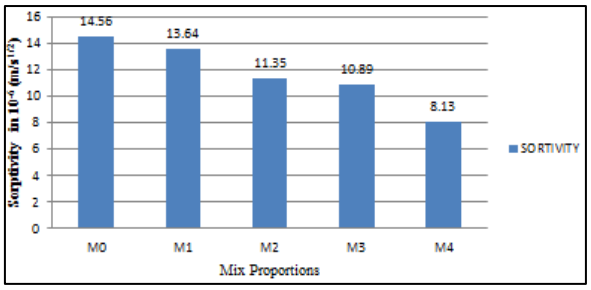


Fig. 9: Sorptivity Results

Fig. 10: Test Setup ForSorptivity

## IV. CONCLUSION

- In this experimental work, RHA used as cement replacement in amount 15% fixed by weight cement and C.S which is utilized as fine aggregate in an amount ranging 10%, 20%, 30% & 40%. The maximum compressive , spilt tensile and flexural strength got 30% replacement of Copper slag as fine aggregate
- Compressive Strength of M25 grade Concrete after 7days increased 17.99% 30% as compared to conventional concrete.
- The compressive strength of M25 grade Concrete after 28days is increased in 8.27% for 30% as compare conventional concrete.
- The split tensile strength for 7days is increased as 20.15% for 30% as compared to conventional concrete.
- The split tensile strength for 28days is increased as 32.09% for 30% as compared to conventional concrete.
- The flexural strength for 7days is increased as 17.33% for 30% as compared to conventional concrete.
- The flexural strength for 28days is increased as 15.29% for 30% as compared to conventional concrete.
- As percentage of copper slag is increasing in the mix, the percentage of voids decreases & also it absorbs less water that found with sorptivity.
- The Sorptivity values of concrete decreases as increase in % of copper slag.

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