World Academics Journal of Engineering Sciences
Vol.7, Issue.2, pp.51-55, June (2020)

Research Paper

E-ISSN: 2348-635X

Study the Behaviour of Copper Slag and Silica Fume in M60 Grade Concrete

Pradeepa P.[1*], Umamaheswari R.[2]

[1]Department of Civil Engineering, Anna University Regional Campus, Madurai, Tamil Nadu, India
[2]Department of Civil Engineering, University College of Engineering, Dindigul, Tamil Nadu, India

**Corresponding Author: npkprathibha@gmail.com*

Available online at: www.isroset.org

Received: 14/Apr/2020, Accepted: 19/May/2020, Online: 30/June/2020

***Abstract*—**This paper illustrate the behavior of partially replaced cement and fine aggregate by silica fume and copper slag in the production of concrete. Silica fume and copper slag are the waste materials that are disposed by the copper smelting industries in large quantities. So in order to utilize the waste materials effectively this study has been carried out. This paper presents the results of an experimental investigation on the concrete using silica fume and copper slag as a partial replacement for cement and fine aggregate respectively. For this study M60 grade concrete were evaluated for workability, compressive strength, spilt tensile strength, flexural strength and water absorption. To determine the strength parameters the specimens were casted for various replacement levels and the harden concrete strength were tested for 7 and 28 days.

***Keywords*—**Compressive strength, Spilt tensile strength,Flexural strength, Copper slag, Silica fume

I. INTRODUCTION

Concrete is a most important engineering material, widely used across the world. In 21st century India is widely used the concrete for road development, airport extension and infrastructural development etc. Due to this vast usage of concrete in India there is a lack of availability for the natural resources especially like river sand and the lack of energy for the huge production of concrete.
Due the vast usage of concrete the depletion of natural resources like sand cause de-vegetation, land slides, water scarcity and more environmental issues. So it is essential today to reduce the excessive consumption of natural resources in order to save the environment. Due to the demand of river sand now a days M-Sand is available in market.

A) OBJECTIVE OF THE PROJECT

The main objective of the project is to study the behaviour of copper slag and silica fume in M60 grade concrete by replacing with cement and fine aggregate. By keeping the silica fume as a constant replacement as 5% and copper slag as replacement of 30%,40% and 50%.The followings were also considered.

- To study the compressive strength of concrete at 7and 28 days.
- To study the spilt tensile strength of concrete at 7 and 28 days.
- To study the flexural strength of concrete at 7 and 28 days.
- Compare the behaviour of copper slag and silica fume replaced concrete with conventional concrete.

B) LITERATURE REVIEW

R.Elamaran et al (2019) have concluded that the behaviour of concrete replaced with copper slag at various percentages (10%,15%, 20%,25%,30% and 35%) in M30 grade possess high compressive strength from 10% to 30% when compared with conventional specimen. Further increase in copper slag the compressive strength gets decreased.

Vikas et al (2018) experimentally investigated that the concrete replaced with silica fume by cement gives high cementitious properties due to their high fineness and also which gives better durability when compared with controlled concrete.

Deepika and Asha (2016) have concluded their idea by replacing copper slag as a fine aggregate in M25 grade concrete up to 100% and replacing a cement by fly ash in two different proportions (30% and 50%). In this the compressive strength is increased up to 100% replacement of fine aggregate with 50% of replacement of cement by fly ash.

II. MATERIALS USED

CEMENT
In concrete cement is a good binding material which is obtained by the cementitious property. The cement should be grey in colour, free from lumps. For this project OPC 53 grade Penna cement is used. The properties of the cement is given in the below table.

Table 2.1 Properties of cement

Properties	Results
Specific gravity	3.15
Initial setting time	28 minutes
Final setting time	532 minutes
Consistency	33%
Fineness modulus	5

FINE AGGREGATE

Fine aggregate used in concrete act as a filling materials. In Normal, the naturally available river sand is used as a fine aggregate but in now a days due to the demand of river sand the crushed stone (i.e M Sand) is available in market. The properties of M Sand which I have used in this project is tabulated below.

Table 2.2 Properties of fine aggregate

Properties	Results
Grading of sand	Zone II
Specific gravity	2.67
Fineness modulus	5.34
Water absorption	0.8%

COARSE AGGREGATE

In concrete the density is increased by the usage of coarse aggregate. Rounded aggregate gives the good workability when compared with other types. In this project 20mm aggregate is used.

Table 2.3 Properties of coarse aggregate

Properties	Results
Specific gravity	2.71
Water absorption	4.38%
Fineness modulus	4..6

COPPER SLAG

Copper slag is a waste product which is from copper manufacturing industries. The gradation of copper slag is similar to that of M.Sand so in this work the fine aggregate is replaced by copper slag in various percentages.

Table 2.4 Properties of copper slag

Properties	Results
Fineness	3.84
Specific gravity	3.45

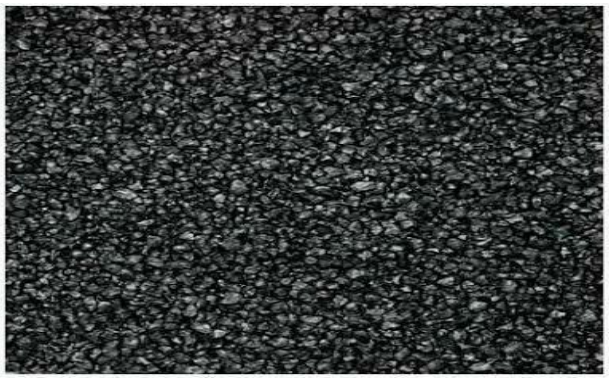


Fig 2.1

SILICA FUME

Silica fume is a by product of silicon ferro silicon alloy production industries. The effective size of the silica fume is 150nm. Silica fume is also called as micro silica due to their high fineness. It acts as a good binding agent.

Table 2.5 Properties of silica fume

Properties	Results
Specific gravity	2.2

Fig 2.2

SUPER PLASTICIZER

Super plasticizer is used to increased the workability of concrete by reducing the water content up to 25%. For this project work Fosroc Conplast SP 430 is used as water reducing agent.

WATER

Water used for mixing, should be free from floating matters and it should not contain any harmful substances. The recommended pH value of water for concrete work should not be greater than 6.5.

III. EXPERIMENTAL PROCEDURE

To know the behaviour of concrete replaced by copper slag and silica fume the design mix is done for M60 grade concrete. Copper slag is replaced by fine aggregate in various percentages while silica fume is replaced as a 5% by the weight of cement.

a) Conventional specimen
b) 5% Silica fume + 30% Copper slag + CA
c) 5% Silica fume + 40% Copper slag + CA
d) 5% Silica fume + 50% Copper slag + CA

The quantities are arrived for the above mentioned various percentages of replacement. Specimens are casted for the calculated quantities. Mix ratio for M60 grade concrete is

Cement	FA	CA	W/C	SP
1	3.6	4.9	0.45	3%

IV. RESULT AND DISCUSSION

A) WORKABILITY TEST

To check the workability of fresh concrete the slump cone test is performed.

Fig 4.1

Table 4.1 Values of Slump

Mix	W/C	Slump (mm)
Conventional	0.45	30
30%CS + 5%SF	0.45	33
40%CS + 5%SF	0.45	39
50%CS + 5%SF	0.45	45

The slump values are increased while increasing the percentage of copper slag due to this the workability also increased. The reason for increased slump is low water absorption of copper slag due to their glossy texture.

B) STRENGTH TEST

To know the strength behavior of copper slag replaced hardened concrete, the specimens were tested. Performed tests are listed below.

1. Compression test
2. Spilt tensile test
3. Flexural test

COMPRESSION TEST

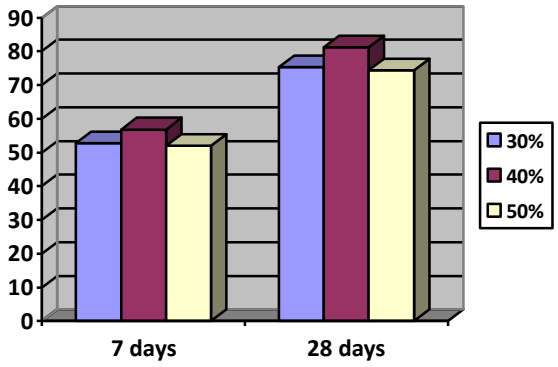
In order to perform the Compression test, totally 24 cubes were casted of having the size of 150mm x 150mm x 150mm. The casted cubes are tested for 7 and 28 days in Universal Testing Machine (UTM). The load is applied gradually up to its failure. Then the compressive strength is calculated in N/mm² using the formula mentioned below.

$$\sigma = P/A$$

Fig 4.2

Table 4.2 Compressive strength test results

Type of specimen	No of specimen	Compressive strength (N/mm^2)		Result (N/mm^2)	
		7 days	28 days	7 days	28 days
Control Specimen	1.	45.69	65.28	47.11	67.30
	2.	47.71	68.15		
	3.	47.93	68.48		
5% SF + 30% CS	1.	53.42	76.32	52.72	75.32
	2.	56.09	80.14		
	3.	48.65	69.50		
5% SF + 40% CS	1.	58.87	84.10	56.84	81.20
	2.	52.78	75.40		
	3.	58.87	84.10		
5% SF + 50% CS	1.	50.96	72.81	52.08	74.41
	2.	56.22	80.32		
	3.	49.07	70.10		



The compressive strength of copper slag replaced specimen is increased for all percentages of replacement level.

- For 30% of replacement 12% of strength is increased for 7 days and 11% of strength is increased for 28 days.
- For 40% of replacement 21% is increased for 7 days and 17% is increased for 28 days.
- For 50% of replacement 11% is increased for 7 days and 9% is increased for 28 days.

SPILT TENSILE TEST

To know the tensile behavior of copper slag replaced concrete 24 cylindrical specimens are casted. The cylindrical specimen is having the size of 150mm diameter and 300mm height. The spilt tensile test is performed for 7 and 28 days. The load at failure is noted for each specimen.

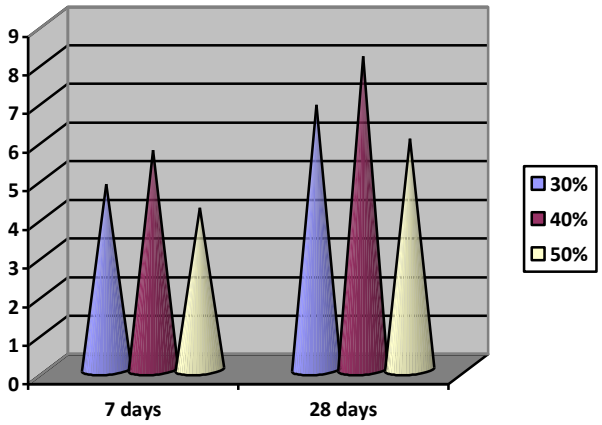
Fig 4.3

The spilt tensile stress is calculated in N/mm² using the formula mentioned below.

$$T = 2P/\pi dl$$

Table 4.3 Spilt tensile test results

Type of specimen	No of specimen	Spilt tensile strength (N/mm²)		Result (N/mm²)	
		7 days	28 days	7 days	28 days
Control specimen	1.	3.79	5.42	3.91	5.6
	2.	4.10	5.86		
	3.	3.83	5.48		
5% SF + 30% CS	1.	4.55	6.50	4.79	6.85
	2.	4.84	6.92		
	3.	4.99	7.13		
5% SF + 40% CS	1.	5.47	7.82	5.67	8.11
	2.	5.94	8.49		
	3.	5.61	8.01		
5% SF + 50% CS	1.	4.19	5.98	4.18	5.98
	2.	4.38	6.25		
	3.	3.98	5.69		



The spilt tensile strength is increased for the copper slag replaced concrete.

- For 30% of replacement 23% is increased for 7 days and 18% is increased for 28 days.
- For 40% of replacement 45% is increased for 7 days and 30% is increased for 28 days.
- For 50% of replacement 7% is increased for 7 days and 6% is increased for 28 days.

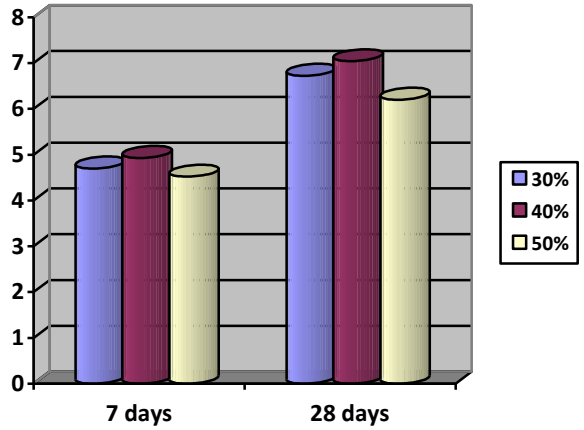
FLEXURAL TEST

Fig 4.4

To check the flexural strength of the specimen totally 24 numbers of prisms are casted which is having the size of 150mm x 150mm x 500mm. Flexural test is also performed for 7 and 28 days. The arrived test results are mentioned in the below table.

Table 4.4 Flexural strength test results

Type of specimen	No of specimen	Flexural strength (N/mm²)		Result (N/mm²)	
		7 days	28 days	7 days	28 days
Control specimen	1.	4.18	5.98	4.27	6.10
	2.	437	6.24		
	3.	4.26	6.09		
5% SF + 30% CS	1.	4.71	6.74	4.70	6.72
	2.	4.61	6.59		
	3.	4.79	6.84		
5% SF + 40% CS	1.	4.87	6.96	4.93	7.04
	2.	4.93	7.05		
	3.	4.98	7.12		
5% SF + 50% CS	1.	4.53	6.48	4.52	6.50
	2.	4.66	6.65		
	3.	4.36	6.23		



The flexural strength of the copper slag replaced concrete is increased when compared with conventional concrete.

- For 30% of replacement 10% is increased for 7 days and 9% is increased for 28 days.
- For 40% of replacement 15% is increased for 7 days and 13% is increased for 28 days.
- For 50% of replacement 5% is increased for 7 days and 6% is increased for 28 days.

V. CONCLUSION

From the above discussion it is concluded that

- The optimum strength is obtained at 40% of replacement level. Hence 40% is chosen as an effective percentage of replacement.
- For 50% of replacement compression, spilt and flexural strength gets decreased.
- For 50% of replacement with the addition of 5% of silica fume the percentage increased for compressive and flexural has shown good percentage of strength increase.

REFERENCES

[1]. M. Kiruthika, "Experimental Study on Partial Replacement of Cement and Fine Aggregate by Silicafume and Copper Slag in concrete", IJIRT, ISSN:2349-6002, volume 4, Issue 8, January 2018.
[2]. Naveed A Shaikh, Pradeep P Tapkire, "A Partial Replacement of Fine Aggregate by Copper Slag in Concrete, " IJECS, ISSN:2319-7242, Volume 5, Issue 12, pp 19809-19812, December 2016.
[3]. M.V Patil, "Properties and Effects of Copper Slag in Concrete" International Journal of Advance in Mechanical and Civil Engineering, ISSN:2394-2827, volume 2, Issue 2, April 2015.
[4]. IS 10262 Recommended to Concrete Mix Proportions Guide Line, BIS, New Delhi, 2019.
[5]. IS 12269 Recommended Specifications for 53 grade Ordinary Portland Cement, BIS, New Delhi, 1987.
[6]. IS 383 Recommended Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete, BIS, New Delhi, 1970.

