International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 6, October 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Effect of Copper Slag on Steel Fiber Reinforced Concrete and Conventional Concrete

Shaik Ashraffur Rahaman[1], K. Srinivas[2]

[1]Student, [2]Assistant Professor,

[1,2]Universal College of Engineering & Technology, Vijayawada, Andhra Pradesh, India

ABSTRACT

Because of Rapid growth of technology and population in India, there is a huge demand for construction material mostly for natural sand, of late excessive consumption of sand caused ecological economical imbalance. To overcome these effects large modifications are being carried out in construction industry, i.e. usage of by products as a replacement of fine aggregate. In the present study COPPER SLAG which is a byproduct obtained during production of copper by smelting is used as a replacement of F.A. And also to increase the mechanical properties of concrete different types of fibers are added to the concrete mix. The HOOKED END STEEL FIBRES are added to the concrete to improve the mechanical properties. As several researchers has introduced Steel fiber reinforced concrete(SFRC) for its inherent superiority over normal plain and reinforced concrete for its higher flexural strength, better tensile strength and modulus of rupture, better ductility and fatigue resistance, crack resistance. This comparative study is carried out on strength properties between SFRC and conventional concrete due to replacement of F.A with copper slag. An experimental investigation was carried out to evaluate the mechanical properties of Steel fiber reinforced concrete by replacement of sand (F.A) with copper slag for different grades (M_{30}, M_{40}**).** Tests are conducted with 1% addition of hooked end steel fibers having aspect ratio 60 and replacement of copper slag by 0%, 10%....with an interval of 10% where optimum strength is attained at 50%,40%.

KEYWORDS: *Copper slag, steel*

How to cite this paper: Shaik Ashraffur Rahaman | K. Srinivas "Effect of Copper Slag on Steel Fiber Reinforced Concrete and Conventional Concrete" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-6, October 2019, pp.93-96, URL: https://www.ijtsrd.com/papers/ijtsrd28038.pdf

IJTSRD28038

INTRODUCTION

Cement concrete is the most extensively used construction material in the world as it provides good workability and can be moulded to any shape due to plasticity before undergoing setting. Ordinary cement concrete possesses very low tensile strength, limited ductility, and little resistance to cracking

Now-a-days civil engineering constructions have their own intended purposes to attain these purposes modification had brought in traditional concrete. It has been found that different type of fibers added in specific percentages to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of Steel Fiber Reinforced Concrete (SFRC) for its superior resistance to cracking and crack propagation. SFRC is now increasingly used in structures such as airport pavement, bridged decks, machine foundations, blast resistant structures, piles, sea protective structures.

Common river sand is expensive due transportation charges and large usage of sand leads to ecological imbalances. Hence to overcome these effects substitute or replacement product for concrete industry has found i.e. copper slag which is an industrial by-product produced during the process of manufacturing copper.

The present study focuses on the effect of copper slag on strength properties of Steel Fiber Reinforced Concrete and Conventional Concrete. Copper Slag as partial replacement of sand in SFRC and Conventional Concrete and results are compared. Comparative study is carried out on steel fiber reinforced and conventional concrete. As the SFRC doesn't undergoes cracking after failure as plain concrete fails due to cracking before failure.

STEEL FIBERS:

Steel fibers used for reinforcing concrete are defined as short, discrete length of steel having an aspect ratio (ratio of length to diameter) from about 20 to 100 according to **ACI-544(3R-08)** with any of several cross sections and that are sufficiently small to be randomly dispersed in a unhardened concrete mixture using usual mixing procedures.

COMPOSITION OF STEEL FIBRES:

- The composition of steel fibers generally includes carbon steel or stainless steel.
- The length dimension ranges from 6.4mm to 76mm while the diameter ranges from 0.25mm to 0.75mm.
- The steel fibers are described by a convenient parameter "Aspect Ratio". The aspect ratio is determined by length to diameter ratio. It varies from 20 to 100 as stated in ACI544, 3R-08.

BENEFITS OF USING STEEL FIBERS IN CONCRETE:

- Steel Fibers are generally distributed throughout a given cross section whereas reinforcing bars or wires are placed only where required
- Steel fibers are relatively short and closely spaced as compared with continuous reinforcing bars of wires.
- Steel Fibers are typically added to concrete in low volume dosages (often less than 1%), and have been shown to be effective in reducing plastic shrinkage cracking.
- Steel Fibers freezes the cracks developed in concrete.

PHYSICAL PROPERTIES:

The specific gravity and density of copper slag and river sand were determined in accordance with IS 2386 part-III. Copper slag has higher density compared with F.A. This may result in production of concrete with higher density. Also, the measured water absorption for copper slag was low compared with sand. This suggests that copper slag has less surface porosity and would require by sand in the concrete mix.

SFRC is a composite material comprised of Portland cement, aggregate, and steel fibers. Normal unreinforced concrete is brittle with a low tensile strength and strain capacity. The function of the steel fibers distributed randomly is to fill the cracks in the composite. Steel Fibers are generally utilized in concrete to manage the plastic shrink cracking and drying shrink cracking. They also less the permeability of concrete and therefore reduce the flow of water. Some types of fibers create greater impact, abrasion and shatter resistance in the concrete. The quantity of fibers required for a concrete mix is normally determined as a percentage of the total volume of the composite materials. The fibers are bonded to the material, and allow the fiber reinforced concrete to withstand considerable stresses during the post-cracking stage. The actual effort of the fibers is to increase the concrete toughness.

BATCHING OF SFRC:

SFRC comprises concrete and steel fibers. The basic concrete mix is defined in the same way as it is for ordinary reinforced concrete. SFRC requires a high quality concrete with a low water/cement ratio, low shrinkage properties and a good blend of quality aggregates. The particular type of steel fibers is chosen in order to achieve specific technical and load-carrying requirements of the SFRC-element. Concrete mix, fiber type and fiber dosage rate have to be harmonized in order to obtain the best possible solution. It should be noted that the addition of steel fibers will reduce the slump of the concrete. Therefore, in order to ensure the workability of the final mix, the slump has to be increased by adding plasticizers s accordingly. It is important to understand that increasing the slump by adding more water is strictly prohibited.

SIEVE ANALYSIS OF FINE AGGREGATE:

Sieve analysis helpful in determining the particle size distribution of the aggregates gradation of fine aggregate. It is confirming to IS 2386 – 1963 part 1

- The main principle in this test is by passing the sample through the set of sieves, each sieve will contain the aggregate in particular range.
- The set arrangement of sieves for sieve analysis of fine aggregate is 10mm, 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ and Pan.

GRADING LIMITS OF FINE AGGREGATE IN SIEVE ANALYSIS (As per IS 383 – 1970):

I.S sieve size	Percentage passing			
	Zone I	Zone II	Zone III	Zone IV
10mm	100	100	100	100
4.75mm	90 – 100	90 – 100	90 – 100	95 – 100
2.36mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18mm	30 – 70	50 – 90	75 – 100	90 – 100
600 µ	15 – 34	35 – 59	60 – 79	80 – 100
300 µ	5 – 20	8 – 30	12 – 40	15 – 50
150 µ	0 – 10	0 - 10	0 - 10	0 – 15

VALUES OF SPECIFIC GRAVITY FOR DIFFERENT MATERIALS:

MATERIALS	SPECIFIC GRAVITY
CEMENT	3.09
FINE AGGREGATE	2.648
COARSE AGGREGATE	2.72
COPPER SLAG	3.5

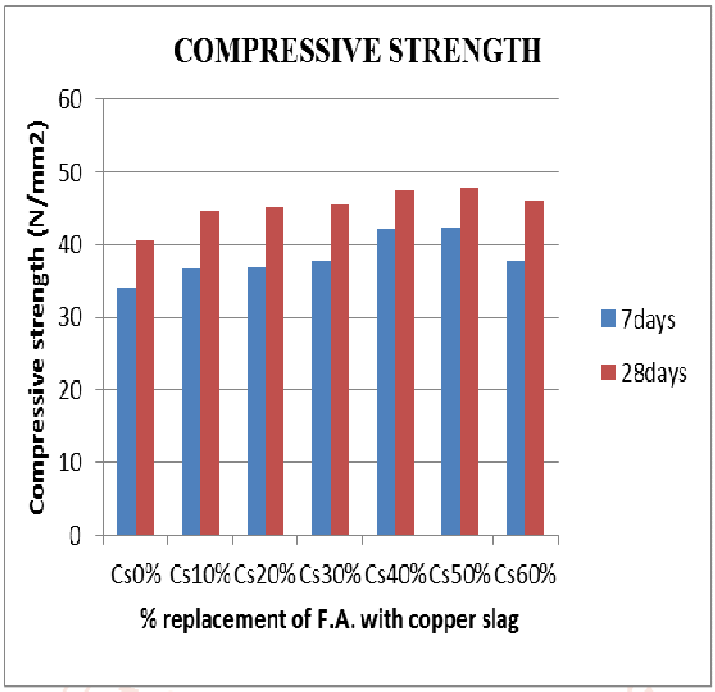
MIX PROPORTION RATIOS FOR M_{30} AND M40:

Grade	Mix Ratio	W/C ratio
M_{30}	1: 1.492: 3.33	0.45
M_{40}	1: 1.36: 3.024	0.43

SLUMP VALUES FOR M_{30} GRADE CONVENTIONAL CONCRETE & STEEL FIBRE REINFORCED CONCRETE:

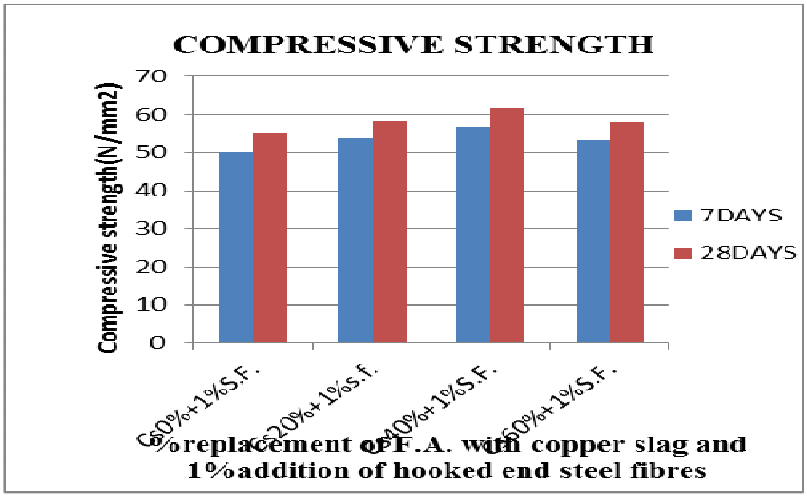
Mix proportion	Slump(mm)
CS0	55
CS1	57
CS2	58
CS3	60
CS4	62
CS5	65
CS6	70

Mix proportion	Slump(mm)
CS0+1%SF	53
CS1+1%SF	56
CS2+1%SF	58
CS3+1%SF	60
CS4+1%SF	62
CS5+1%SF	65
CS6+1%SF	68



COMPRESSIVE STRENGTH FOR SFRC CONCRETE (MPA)

Mix appellation	Compressive Strength			
	7days		28days	
	Load(KN)	Strength	Load(KN)	Strength
Cs0%+1%S.F	970 920 880	41.18	1090 1070 1020	47.032
Cs20%+1%S.F	1060 1010 970	45.03	1200 1180 1130	53
Cs40%+1%S.F	1220 1190 1130	52.44	1280 1260 1210	55.56
Cs60%+1%S.F	1140 1100 1080	49.705	1200 1180 1150	52.29



COMPRESSIVE STRENGTH, FLEXURAL STRENGTH, SPLIT TENSILE STRENGTH FOR CONVENTIONAL CONCRETE (MPa):

Mix appellation	Compressive Strength		Flexural Strength	Split Tensile Strength
	7days	28days	28days	28days
Cs0%	33.9	40.44	4.32	2.02
Cs10%	36.74	44.74	4.73	2.19
Cs20%	36.89	45.08	4.9	2.4
Cs30%	37.77	45.48	5.33	2.63
Cs40%	42.07	47.41	5.72	2.87
Cs50%	42.308	47.85	6.0	3.0
Cs60%	37.653	46.07	5.63	2.56

CONCLUSION

- The optimum strength for M_{30}&M_{40} grade concrete is observed at 50%&40% replacement of copper slag with fine aggregate.
- Due low water absorption nature copper slag there is a increase in the workability of conventional concrete when compared with steel fiber reinforced concrete due addition of hooked end steel fibers.
- Maximum percentage increase of compressive strength for conventional concrete is 29.4where as for steel fiber reinforced concrete is 34.28% for M_{30}.
- Maximum percentage increase of compressive strength for conventional concrete is 20.5% whereas for steel fiber reinforced concrete is 23% for M_{40}.
- Steel fiber reinforced concrete is having an increase in compressive strength is 7%, Flexural strength is50%, Split tensile strength is 68% when compared with conventional concrete.
- So addition of hooked end steel fibers increases mechanical properties of concrete and also provides superior resistance to cracking.
- While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of member in two piece geometry. But due to addition of steel fibers in concrete cracks gets ceased which results into the ductile behavior of SFRC.
- Increase in replacement of copper slag with F.A beyond the optimum percentage causes increase in workability and causes strength reduction. Increase in fiber content can result in balling effect and reduces workability according to ACI544 (3R-08) it is advisable up to 0.5%-1.5%. Further researches can be carried out to improve the strength and acid resistance by the addition of some admixtures.

REFERENCES

[1] Amit Rana (2013), Some Studies on Steel Fiber Reinforced Concrete, International Journal of Emerging Technology and Advanced Engineering, Volume 3, 120-127.

[2] Binaya Patnaik (2015), Strength and Durability Properties of Copper Slag Admixed Concrete, International Journal of Research in Engineering and Technology, Volume 4, 158-166.

[3] IS 383: 1970, Specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian standards, New Delhi, India

[4] IS 10262-2000, recommended guidelines for concrete mix design, Bureau Standards, New Delhi, India

[5] IS: 516-1959, Indian standard methods of tests for strength of concrete, Bureau of Indian standards, New Delhi, India.

[6] Milind V. Mohod, "Performance of steel fibre reinforced concrete", International Journal of Engineering and Science, ISSN: 2278-4721, Vol. 1, Issue 12 (December 2012), PP 01-04.

[7] Leema Rose A & SuganyaP (2015), 'Performance of Copper Slag on Strength and Durability Properties as Partial Replacement of Fine aggregate in Concrete' International Journal of Emerging Technology and Advanced Engineering, vol .5, pp: 434-437.

[8] Nguyan Van Chan H (2002), 'Steel fiber reinforced concrete', Journal of Civil Engineering, Ho Chi Minh City University of Technology, vol.1, pp: 108 -116.