International Journal of Research in Engineering, Science and Management
Volume-2, Issue-10, October-2019
www.ijresm.com | ISSN (Online): 2581-5792

An Experimental Investigation on Partial Replacement of Fine Aggregate by M-Sand and Cement by Steel Slag

M. Ravindaran[1], S. Tharanya[2]
[1]*PG Student, Department of Civil Engineering, Nandha Engineering College, Erode, India*
[2]*Assistant Professor, Department of Civil Engineering, Nandha Engineering College, Erode, India*

***Abstract*: The paper reports the effect of concrete using copper slag and M-sand as fine aggregate replacement. In this project work, the concrete grade M60 was selected and IS method was used for mix design. The properties of materials for cement, fine aggregate, coarse aggregate, copper slag and M-sand were studied for mix design. The various strength of concrete like compressive, split tensile, flexural were studied for various replacement of fine aggregate using copper slag and M-sand that are 0%, 10%, 20%, 30%, 40%, 50% and 60%. The maximum compressive strength of concrete attained at 40% replacement of fine aggregate at 7, 14 and 28 days. The split tensile strength and the flexural strength were also obtained higher strength at 40% of replacement level at 28 days.**

***Keywords*: Cement, fine aggregate, coarse aggregate, copper slag, M-sand & Sulphonated Naphthalene Formaldehyde SP430**

1. Introduction

The copper slag in industrial is large and increases with time. In each country the copper slag composition is different, since it is affected by socioeconomic characteristics, consumption patterns and waste management programs, but generally the level of copper slag in waste composition is high. The largest component of the copper slag smelting. The large volume of materials required for construction is potentially a major area for the reuse of waste materials. Recycling in concrete has advantages since it is widely used and has a long service life, which means that the waste is being removed from the waste stream for a long period. Because the amount of mineral aggregates required in concrete is large, the environmental benefits are not only related to the safe disposal of bulk waste, but also to the reduction of environmental impacts arising from the extraction of fine aggregates.

A. Definition of copper slag

Copper slag is a by-product of copper extraction by smelting. During smelting, impurities become slag which floats on the molten metal. Slag that is quenched in water produces angular granules which are disposed of as waste or utilized as discussed below.

B. Definition of M-sand

Crushed stone sand is produced by crushing boulders. Manufactured sand is produced by rock-on-rock or rock- on-metal Vertical Shaft Impactor (VSI) in which the process that produced alluvial deposits is closely simulated. Particle size reduction and achieving equidimensional shape is critical to get desired properties. If rock is crushed in compression lot of inherent properties exhibited by natural river sand are lost.

Cement: Ordinary Portland Cement of 53-grade was used as it satisfied the requirements of IS: 269- 1969 and results have been tabulated in table 1.

Table 1
Properties of cement

Properties of cement	
Specific gravity	3.15
Consistency	33%
Fineness	6.3
Initial Setting Time	45 minute
Final Setting Time	480 minutes

Coarse Aggregate: coarse aggregate shall comply with the requirement of IS 383 as for as possible crushed Aggregate shall be used for ensuring adequate durability. The aggregate used for concrete the nominal maxi size of coarse aggregate used in Production of shall be 20 mm.

Fine aggregate: Fine aggregate shall conform to requirement of IS 383 for river sand. Aggregates are the major ingredients of concrete, as they constitute 70-75% of the total volume, provide a rigid skeleton structure for concrete, and act as economical space fillers. In India river sand is used as fine aggregate. The sand was washed and screened at site to remove deleterious materials and tested as per the procedure given in IS: 2386-1963 and the test results should comply with the requirements of IS383-1970.

Table 2
Test on aggregates

Test	Types of Aggregate		
	Coarse	Fine	copper
Specific Gravity	2.9	2.88	3.51
Water Absorption	0.5%	3.5%	Nil
Moisture content	Nil	Nil	Nil

Water: For this study portable water available in the campus with pH value 7 and conforming to the specifications of IS456-2000 is used for concreting as well as curing of the specimens.

Copper slag: Copper slag used for this work is taken from Suyog suppliers (zone-II), a dealer in Pune which is used for sand blasting and the supplier brought the slag from Baruch, thoothukudi.

Slag is a co-product of the iron and steel making process. The use of steel slag aggregates in concrete by replacing natural aggregates is a most promising concept. Steel slag aggregates are already being used as aggregates in asphalt paving road mixes due to their mechanical strength, stiffness, porosity, wear resistance and water absorption capacity.

Table 3
Properties of copper slag

Physical Properties	Remarks
Particle shape	Irregular
Appearance	Black & glassy
Specific gravity	3.51
Fineness modulus of copper slag	3.47
Particle size	0.075 mm to 4.75 mm
Hardness	Between 6 and 7

Plastizers: Sulphonated Naphthalene Formaldehyde SP430 is used as directed by the manufacture to improve the workability of fresh concrete mix.

2. Design mix

The HSC is defined as higher concrete whose characteristic strength ranges from 50 and above. Hence for my work I'm considering M60 grade concrete. The mix design for M60 grade concrete is carried out using the Indian standard code 10262:2009. For which the water cement ratio is kept as the least value of 0.35 for the slump value is assumed as 100mm, the fine aggregate of Zone II, coarse aggregate of 20mm size and below.

- Cement = 446 Kg/m^3
- Water = 156 liter
- Fine Aggregate = 856 Kg/m^3
- Coarse Aggregate = 1171 Kg/m^3
- Admixture = 2% of Sulphonated Naphthalene Formaldehyde SP430
- The proportion for the mix is 1:1.92:2.62:0.35

Specific gravity and bulk density Procedure

- The weight of the container (W1) is determined
- The container is filled with coarse aggregate and weighed (W2)
- Then the container is filled with water up to the top surface level and weighed (W3)
- The container is emptied and is filled with water and weighed (W4)
- Specific gravity of coarse aggregate= (W2 – W1) / [(W4 – W1) – (W3 – W2)]
- Specific gravity of coarse aggregate = 2.85
- Bulk density of coarse aggregate = (W2 – W1) / (W4 – W1)
- Bulk density of coarse aggregate = 1386 kg/m3

Bulk density:

The bulk density of unit weight of an aggregate gives valuable information regarding the shape and grading of aggregate. For a specific gravity the angular aggregate show a lower bulk density. The bulk density depends on the particle size distribution and shape of the particles. One of the early methods of mix design makes use of this parameter bulk density in proportioning of concrete mix. The higher the bulk density the lower is the voids content to be filled by sand and cement. The sample which gives the minimum voids or the one which gives maximum bulk density is taken as the right sample of aggregate for making economical mix. The method of determining bulk density also gives the method for finding out void content in the sample of aggregate.

3. Conclusion

- From theresult and discussions, the following conclusions were made.
- The replacement of fine aggregate using copper slag in concrete there by increases the self- weight of the concrete.
- The workability of concrete increased with the increase in copper slag content of fine aggregate replacements at same water-cement ratio.

Scope for further study

- A much more extensive study on the properties and behavior of concrete with Eco-sand can be made.
- Investigation may be done for higher grades of concrete and with different water cement ratios with same materials.
- Study on concrete with full replacement of Eco-sand as fine aggregate can be done.
- Further investigation on resistance of concrete with steel slag aggregates to attack by sulfates, acid, and alkali silica reactions, carbonation, harmful chemicals and resistance to high temperatures can be carried out.
- Fire resistance capacity of steel slag aggregate concrete may be investigated.
- Due to presence of several dangerous heavy metals and salts in the steel slag aggregates, leaching tests can be carried out to verify its environmental compatibility.
- A broad study can be done on durability characteristics of concrete with steel slag and Eco-sand as coarse and fine aggregate replacements.
- Age maturity concept and corrosion studies can be carried or further as the normal aggregate is replaced with steel slag in concrete.

References

[1] Saeed Ahmad, Shahid Mahmood, “Effects of crushed and natural sand on the properties of fresh and hardened concrete,” August 2008.
[2] M. Adams Joe, M. Prem Anand., et. al., “Experimental Investigation on the Effect of M-Sand in High Performance Concrete.”
[3] Praveen Kumar K, Radhakrishna, “Strength and workability of cement mortar with manufactured sand.”
[4] K. S. Suchithra, N. S. Kumar, et. al., “Experimental Investigation Manufactured Sand as a Partial Replacement Material of Fine Aggregate in Self-Compacting Concrete.”
[5] Nimitha, Vijayaraghavan, et. al., “Effect of Manufactured Sand on Durability Properties of Concrete.”
[6] V. Subathra Devi, B. K. Gnanavel. “Properties of concrete manufactured using steel slag.”
[7] S. Priya, A. Siva. Et. al., “Experimental Investigation on Partially Replacement of Cement by Steel Slag.”
[8] Dilip K. Kulkarni and Priyanka A. Jadhava, “The Properties of Concrete containing Manufactured Sand,” 2006.