Second International Conference on Nexgen Technologies
Sengunthar Engineering College, Tiruchengode, Namakkal Dist. Tamilnadu (India)
8th - 9th March 2019 www.conferenceworld.in ISBN : 978-93-87793-75-0

EXPERIMENTAL STUDY ON STRENGTH AND DURABILITY OF CONCRETE BY PARTIALLY REPLACING FINE AGGREGATE WITH COPPER SLAG, INDUSTRIAL SLUDGE AND USING TREATED WATER

[1]M.Velumani, [2]S.Karthikadevi,[3] B.Mukila

[1]Assistant Professor, K.S.Rangasamy College of Technology, Namakkal, Tamil Nadu,
[2]Assistant Professor, Coimbatore Institute of Technology (CIT) in Coimbatore,
[3] UG Scholar Department of Civil Engineering, K.S Rangasamy College of Technology, Tamil Nadu

ABSTRACT

This paper reports the effect of concrete by partially replacing fine aggregate with copper slag and industrial sludge and using treated water instead of tap water. In this project work, the concrete grade M35 was selected and IS method was used for mix design. The properties of material for cement, fine aggregate, industrial sludge, copper slag and treated water were studied for mix design. The various strength of concrete like compressive, flexural and split tensile were studied and non-destructive test such as rebound hammer test and ultrasonic pulse velocity measurement were studied for various replacements of fine aggregate using industrial sludge that are 5%,10%,15% and copper slag that is 25% and water cement ratio that is 0.45. since the concrete is tested against acid attack curing is done by replacing water with hydro chloric acid. The concrete is tested after curing period of 7, 14 and 21 days.

KEY WORDS

Copper slag, Industrial sludge, treated water, Fine aggregate, corrosion resistance.

1. INTRODUCTION

Concrete is the most widely used construction material in Civil Engineering projects in worldwide. Huge quantities of different types of concrete have been produced annually. From various kind of concrete fibre reinforced is one of the most interesting subjects for researchers. The ingredients of conventional concrete are cement, fine aggregate, coarse aggregate and water. Some improvements in the concrete field, which can be made by adding of some new material in to it. Adding every new material makes some kind of impact on the concrete but the impact

should be positive and it is pleasant**.** Natural resources are depleting worldwide while at the same time the generated wastes from the industry are increasing substantially. The sustainable development for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment. The rapid increase in the natural aggregates consumption every year due to the increase in the construction industry worldwide means that the aggregates reserves are being depleted rapidly, particularly in desert countries such as Arebian Gulf region. If we are able to use the copper slag in place of natural sand then we can successively obtain a material to replace the sand, which is eco-friendly and cost effective. Hence there is a growing need to find the alternative solution for the slag management. In the present study, it is proposed to study the effect of addition of copper slag mixed with natural sand in concrete. Copper slag is a by product obtained during the melting and refining of copper. Apart from the conventional copper products, slag is obtained as a byproduct in a quantity of about 1000 tonnes per day. The ability of copper slag to produce normal strength concretes in different forms, cement replacement, coarse aggregate or as a substitute for fine aggregate has been reported.

2. LITERATURE REVIEW

- Jayapal Naganur,Chethan "Effect of Copper Slag as a Partial Replacement of Fine Aggregate on the Properties of Cement Concrete" This paper presents the results of an experimental investigation on the properties of concrete using copper slag as partial replacement of fine aggregate For this research work, M35 grade concrete was used and tests were conducted. Various concrete mixtures were prepared with different proportions of copper slag as fine aggregates replacement. Concrete mixtures were evaluated for workability, compressive strength, splitting tensile strength, corrosion, acid resistivity and microstructural analysis.

- Rushabh A. Shah, Jayeshkumar Pitroda "Effect of Water Absorption and Sorptivity on Durability of Pozzocrete Mortar" After evaporation of excess water in the mortar, voids inside the mortar creates capillaries which are directly related to porosity and permeability of the mortar Due to incomplete compaction; mortar may consists gel pores & capillary pores, which leads to low strength of mortar. Due to problems associated with the absorption test and permeability test; which are measuring the response of mortar to pressure which is rarely the driving force of fluids entering in to mortar; hence there is a need for another type of test. Such tests should measure the rate of absorption of water by capillary suction; "sorptivity" of unsaturated mortar.

- Ismail Ozgur Yaman, Gokhan Inei, Nazli Yesiller, and Haluk M. Aktan "Ultrasonic Pulse Velocity in Concrete Using Direct and Indirect Transmission" This paper presents the experimental study on ultra sonic pulse velocity test on concrete The relationship between velocities ofultrasonic stress waves transmitted along direcr and indirect paths was investigated. Tests were conducted on plain concrete slabs of dimensions 1000 x 1500 mm, with a thickness of 250 mm A test procedure, described in BS 1881 to determine indirect wave velocities, was refined by defining the number and spacing of transducers. Comparisons were made between direct and indirect wave velocity measurements using staristical analysis. The statistical analysis revealed thar direct and indirect wave velocities could be used interchangeably in evaluating the properties of the concrete.

- M.Devi, V.Rajkumar, Dr.K.Kannan "Inhibitive effect of organic inhibitors in concrete containing quarry dust as fine aggregate" Concrete is the widely used building material in the world. River sand has been the most popular choice for the fine aggregate in concrete in the past, but overuse of the material has led to environmental concerns, reduction of sources and an increase in price. Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete. The concrete containing well graded quarry dust as fine aggregate along with plasticizer can be effectively utilized in the construction industry. Addition of the organic inhibitors to quarry dust replaced concrete, offered very good resistance against chemical attack and increases corrosion resistance by forming thin oxide layer to prevent outside agents and shielding the anodic sites.

3. EXPERIMENTAL PROGRAM AND TEST RESULTS

The materials used for making concrete were tested before casting the specimen in order to design the mix proportions. The preliminary tests were conducted on the materials that is cement, fine aggregate, copper slag, industrial sludge and treated water.

4. PHYSICAL PROPERTIES OF AGGREGATES

The following table represents the physical properties as a result of experimental study on respective aggregates

Properties	Fine aggregate	Copper Slag	Cement
Specific gravity	2.58	3.79	3.15
Fineness modulus	2.49	2.45	2.5
vWater Absorption %	1.07	0.4	0.68
Unit weight per Kg/m^3	1653	1886	1890

5. OBJECTIVES AND SCOPE OF STUDY

- To study the properties of the copper slag and industrial sludge that is used as a partial replacement for the fine aggregate.
- To arrive the mix design for the modified concrete as per the IS code.
- To study the compressive strength of the modified concrete in 7 & 28 days.
- To compare the workability and various strengths for different percentage substitutions of sand with copper slg and industrial sludge.

6. MATERIALS USED

6.1 CEMENT

Ordinary Portland cement of 53 grade with specific gravity of 3.15 has been used. The initial setting time and final setting time were found to be 33min and 315min respectively.

6.2 FINE AGGREGATE

The natural river sand available in local market is used. Locally available natural river sand passing through 4.75 mm I.S. Sieve with a fineness modulus of 2.74, and water absorption of 1.5% in saturated surface dry (SSD) condition was used. The specific gravity of the sand is found to be 2.63 and was confining to ZONE-III.

6.3 WATER

Potable fresh water available from local sources free from deleterious materials was used for mixing and curing of all the mixes tried in this investigation. W/C ratio is taken as 0.45 for M35.

6.4 COPPER SLAG

Its specific gravity was found to be 3.79. The moisture content was found to be 0.0075 and bulk density was recorded as 1886 kg/ m3. After sieve analysis the particle size distribution of the copper slag is determined. The maximum particles were in the range of 600 microns and 150 microns.

6.5 INDUSTRIAL SLUDGE

Sludge is a semi solid slurry and can be produced as sewage sludge from waste water treatment process or as a settled suspension obtained from conventional drinking water treatment and numerous other industrial processes. In other words sludge is concentrated, semi liquid waste left after treatment of industrial water or waste.

6.6 TREATED WATER

Water treatment is any process that improves the quality of water to make it more acceptable for a specific end use. The end use may be drinking, industrial water supply, imigation, river flow maintenance, water recreation or many other uses, including being safely returned to the environment.

6.7 ACID

A lower pH means a higher acidity, and thus a higher concentration of positive hydrogen ions in the solution. Chemicals or substances having the property of an acid are said to be acidic. Here we use HCl for curing in order to test the acid attack on concrete.

7. TEST TO BE CONDUCTED

Compressive strength test, split tensile test, water absorption test, ultra sonic pulse velocity test.

8. CONCLUSION

It could be studied that Copper slag has harness in the range 6 to 7. The specific gravity varies from 3.5 to 3.91. Bulk density is in the order of 1.70 to 3.8 g/cc. The Fe_2O_3 content in the slag fluctuates between 53 % to 68.29%. While the SiO_2 content varying in between 25.84% to 35%, the Al_2O_3 concentration is in the order of 0.22% to 5 %. Due to the physical and mechanical property, slag enjoys various reuse applications. Reuse of copper slag has the dual benefit of safe disposal and judicial resource management. Application in concrete as an admixture, replacement of cement and as a fine aggregate has very good scope in the future. Further research is warranted to analyze the scope for reuse extensively.

REFERENCES

1. Akihiko, Y. and Takashi, Y. "Study of utilisation of copper slag as fine aggregate for concrete", Ashikaya Kogyo Daigaku Kenkyu Shuroku, Vol. 23, pp. 79-85, 1996.

2. Al-Jabri, K. and Makoto Hisada. "Copper slag as sand replacement for high performance concrete", Cement & Concrete Composites, Vol. 31, pp. 483- 488, 2009.

3. Al-Jabri, K., Taha, R. and Al-Ghassani, M. "Use of copper slag and cement by-pass dust as cementitious materials" Cement, Concrete Aggregates, Vol. 24, No.1, pp. 7-12, 2005.

4. Al-Jabri, K.S., Abdullah, H., Al-Saidy and Ramzi Taha. "Effect of copper slag as a fine aggregate on the properties of cement mortars nd concrete", Construction and Building Materials, Vol. 25, pp. 933-938, 2011.

5. Al-Jabri, K.S., Taha, R.A., Al-Hashmi, A. and Al-Harthy, A.S. "Effect of copper slag and cement by-pass dust addition on mechanical properties of concrete", Construction and building materials, Vol. 20, pp. 322-331, 2006.

6. Alpa, I. and Deveci, H. "Utilization of flotation wastes of copper slag as raw material in cement production", Journal of hazard materials, Vol. 159, No. 2, pp. 390-395, 2008.

7. Al-Jabri, K.S., Makoto Hisada, Abdulla, H.A. and Al-oraini, S.K. "Performance of high strength concrete made with copper slag as a fine aggregate", Construction and building materials, Vol.23, pp. 2132-2140, 2009.

8. Alnuaimi, A,S Effects of Copper Slag as a Replacement for Fine Aggregate on the Behavior and Ultimate Strength of Reinforced Concrete Slender Columns" TJER 2012, Vol. 9, No. 2, 90-102

9. Arino, A.M. and Mobasher, B. "Effect of copper slag on the strength, and toughness of cementitious mixtures", ACI Materials Journal, Vol. 96, No. 1, pp. 68-75, 1999.

10. Ayano Toshiki, Kuramoto Osamu, and Sakata Kenji, "Concrete with copper slag fine aggregate", Society of Materials Science, Vol. 49, pp. 1097-1102, 2000.

11. Ayano, T. and Sakata, K. "Durability of concrete with copper slag fine aggregate", Proceedings of the fifth ACI international conference on durability of concrete, Vol.192, pp.141-158, 2000.

12. Ayano, T., Kuramoto, O. and Sakata, K. "Concrete with copper slag as fine aggregate", Jounal of Society Material Science Japan, Vol. 49, No. 10, pp. 1097-1102, 2000.

13. Bipra Gorai, Jana, R. K. and Premchand, "Characteristics and utilisation of copper slag-a review", Resources, Conservation and Recycling, Vol. 39, No. 4, pp. 299-313, 2002.

14. Brindha,D and Nagan,S, " utilization of copper slag as a partial replacement of fine aggregate". International Journal of Earth Sciences and Engineering, Vol.3, No.4, August 2010, PP:579-585.

15. Brindha,D and Nagan,s, " Durability studies on copper slag admixed concrete", Asian Journal of Civil Engineering (Building and housing), Vol.12, No.5 , 2011,PP:563-578.

16. Brindha,D et al, ' Assessment of corrosion and durability characteristics of copper slag admixed concrete, International Journal of Civil and Structural Engineering, Vol.1,No.2, 2010, PP: 192-211. 17