

Analysis of Unconscious Properties and Strength Measurements for Concrete Containing Copper Slag-Review

M.Velumani^{1*}, S.Sakthivel¹, K.Yuvaraj¹

¹ Assistant Professor, Department of Civil Engineering, K.S.Rangasamy College of Technology, Tiruchengode, Tamil Nadu, India

*Corresponding author E-Mail ID: mvelumani84@gmail.com

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ABSTRACT

The main aim of the environmental protection agencies and the government are to seek ways and means to minimize the problems of disposal and health hazards of by products. It is considered as a waste material which could have a promising future in construction industry as substitute of either cement or coarse aggregates or fine aggregates. Copper slag is one of the replacement mechanisms of material in concrete. Use of copper slag as a replacement for fine aggregate in concrete cubes various strength measurements was experimentally investigated in this study. Mainly contents of that M35 conventional concrete and copper slag as a replacement of fine aggregate in 10%, 20%, 30%, 40%, 50%, 60%, 80%, and 100% and also Portland Pozzolana Cement is noted. In this regard, laboratory study including water absorption test, bond strength, and percentage of voids, compressive strength & bulk density were conducted in ppc cement concrete which made by copper slag waste as a replacement of fine aggregate and PPC. A substitution up to 40-50% as a copper slag as a sand replacement yielded comparable strength to that of the conventional concrete. However, addition of more copper slag resulted in strength reduction due to the increase in the free water content in the mix, cured period in a curing tank for later resulting at 28 and 60 days.

Keywords: Copper slag, PPC, water absorption test, bond strength

1. INTRODUCTION

Natural resources are essential for the development of infrastructures in the construction industry. Nowadays there is more demand for the construction materials like aggregates. The wastes from the industries are also increasing day by day. In order to find better solution for this problem, we have to use the non-conventional, innovative materials and recycling of waste materials. By this, the industrial wastes can be utilized and it also reduces the consumption of natural resources. The increased industrial wastes cannot be controlled due to the increased growth of population. Moreover, the disposal of the industrial wastes is also a problematic one since the availability of land is very less. Therefore, we need to use the industrial wastes in an effective manner. Already coal fly ash, silica fume, ground granulated blast furnace are used for the constructions.

PRODUCTION OF COPPER SLAG

Day to day activities of human kind involve production of many things required for consumption and other purposes. Industries form very important units in manufacturing essentials

goods. By product, which results from the process of making, invites care in the safe disposal. “Mass can neither be created nor destroyed” is the law of conservation of mass. According to the above law, total mass on the universe remains constant. As the water present in various forms (sea water, clouds, rainwater, ice, water vapour, surface water and groundwater) in the hydrological cycle, raw material used in the manufacturing process appears into product and by-product. The concept of reuse of waste by-product has now-a-days become both environmental concern and resources management.

Cement

The cement used in this study was 53 grade ordinary Portland cement (OPC) IS: 8112-1989 & Portland pozzolana cement (PPC).The properties of cement used are given in Table 4. 1.

Fine aggregate

Natural river sand is used as fine aggregate. The properties of fine aggregate are determined by conducting tests as per IS: 2386 (part-3).The results indicate that the fine aggregate conforms to zone-III of IS: 383-1970 .Specific gravity of fine aggregate is 2.70.Fineness modulus of fine aggregate is 2.60.

Coarse aggregate

Crushed granite jelly obtained from machine crusher is used as a coarse aggregate. The aggregate passing through 20mm and retaining on 4.75mm is used. Specific gravity of coarse aggregate is 2.78. Fineness modulus of coarse aggregate is 7.10 used.

Portable water

Portable water free from injurious salts is used for mixing and curing.

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Chemical properties of copper slag

Chemical composition of ordinary Portland cement and copper slag are shown below:

The major contents in the copper slag are iron, silica, aluminium, calcium oxide, potassium oxides and magnesium oxides. but copper content is limited to 0.5% to 2%

Depending upon the type of furnace used in smelting of copper slag the chemical compositions in the slag gets varied.

The lime content in copper slag should be of sufficient quantity in order to attain the strength of concrete earlier. Portable water

Portable water free from injurious salts is used for mixing and curing.

Physical properties of copper slag

Copper slag has the physical properties similar to the sand, so it can be used as the partial or full replacement for fine aggregates.

Normally the physical appearance of copper slag is black coloured and of glassy appearance. The unit weight of copper slag is higher than that of conventional concrete.

The specific gravity and bulk density of copper slag is greater than that of sand is high density of concrete

R R Chavan & D B Kulkarni

The effect of using copper slag as replacement of fine aggregate on the strength properties and concluded that Maximum Compressive strength of concrete increased by 55% at 40% replacement of fine aggregate by copper slag. Replacement of fine aggregate by copper slag, concrete gain more strength than control mix concrete strength. For all percentage replacement of fine aggregate by Copper slag the flexural strength of concrete is more than control mix. The flexural strength of concrete at 28 days is higher than design mix for 20% replacement of fine aggregate by Copper slag, the flexural strength of concrete is increased by 14%.Compressive strength and flexural Strength is increased due to high toughness of copper slag.

Alnuaimi.AS

The use of CS as a replacement for FA is environmentally helpful due to the reduction in the waste produced from the copper manufacturing process. The maximum difference in concrete strength between the mixes of 0% CS and 100% CS was 29%, with the difference between the measured control failure loads between the columns with 0 and 100% CS was 20% the maximum difference in the measured EI between columns with 0 and 100% CS was 25%.

Gupta R.C et al

The compressive strength, flexural strength and split tensile strength of concrete is improved due to the addition of discarded rubber tyres and copper slag. It was obtained from the ultrasonic pulse velocity test, the copper slag and rubber tyre admixed concrete have excellent quality. The compressive strength increased up to 36% in copper slag concrete. Water absorption of copper slag admixed concrete is similar to normal concrete and that of rubber tyre admixed concrete is greater than normal concrete.

The utilization of copper slag as a partial replacement for sand; imparts strength up to 50% replacement. It can be applied for all construction activities. Concrete mix having discarded 16 rubber tyres up to 15% (for coarse aggregates) can be applied for construction of pavements, minor works etc.

Brindha.D et al

The use of copper slag in cement and concrete provides additional environmental as well as technical benefits for all related industries. Replacement of copper slag in both fine aggregates and cement replacement reduces the cost of making concrete. Replacement of copper slag increases the self weight of concrete specimens to the maximum of 15 to 20%. The compressive and split tensile strength decreases due to an increase of free water content in the mix. The results of compressive, split tensile strength test have indicated that the strength of concrete increases with respect to the percentage of slag added by weight of fine aggregate up to 40% of additions and 15% of cement.

Meenakshi Sudarvizhi.S,Ilangovan.

The highest compressive strength obtained was 46MPa (for 100% replacement) and the corresponding strength for control mix was 30MPa. It has been observed that up to 80% replacement, CS and FS can be effectively used as replacement for fine aggregate. The results show that the compressive strength of CS&FS concrete is increased when compared to control concrete (30.23MPa to 46.18MPa cured at 90 days).The results show that the split 15 tensile strength of CS&FS concrete is increased when compared to control concrete should be cured for 90 days.

Al - Jabri et al

The effect of using copper slag as a fine aggregate on the properties of cement mortars and concrete. Various mortar and concrete mixtures were prepared with different proportions of copper slag ranging from 0% to 100% as fine aggregates replacement. Cement mortar mixtures were evaluated for compressive strength, where as concrete mixtures were evaluated for workability, density, compressive strength, tensile strength. There was more than 70% improvement in the compressive strength of mortars with 50% copper slag substitution in comparison with the control mixture. when there is a slight increase in density of nearly 5% as copper slag content increases. The workability increased significantly as copper slag percentage increased .The addition of more copper slag resulted in strength reduction due to the increase in the free water content in the mix. The results shows that surface water absorption decreased as copper slag content increases upto 50% replacement. Therefore, it was recommended that upto 40–50% of copper slag can be used as a replacement for fine aggregates in order to obtain a concrete with good strength and durability requirements.

D. Brindha and S.Nagan

The effect of replacing fine aggregate by copper slag on the compressive strength and split tensile strength and found that the percentage replacement of sand by granulated copper slag were 0%,5%,10%,15%,20%,30%,40% and 50%. The compressive strength was observed to increase by about 35-40% and split tensile strength by 30-35%. The experimental investigation showed that percentage replacement of sand by copper slag shall be up to 40%.

Yang HS et al

“Copper slag with magnesium oxide as pozzolanic material, soundness, pozzolanic activity and microstructure development”. The consumption calcium hydroxide showed the slag exhibits high pozzolanic activity, which has higher than that of flyash.

Madhavi et al

Stabilize the slope in retaining walls against seismic forces using copper slag as backfill material. The wall constructed with copper slag backfill showed lesser faces deformations compared with sand.

Shanmuganathan et al

Copper slags are generated as waste word wide during the copper smelting process. It can be used in many applications such as concrete, landfills, Ballasts, bituminous pavements, tiles etc. The apprehension of environmental hazard from the viewpoint of leaching of heavy metals from the slag and its long-term stability in extreme environmental conditions is studied by Shanmuganathan et al., and it was reported that sulphuric acid, leaching the heavy metals present in the slag are very stable and have poor leachability. They suggested that the slag is safe to be considered for use in a wide variety of applications such as for Portland cement, building materials such as tiles and bituminous pavement constructions. The slag samples are non-toxic and has no environmental hazard.

Tixier et al

The effect of copper slag on the hydration of cement based materials. A decrease in capillary porosity was observed while the gel porosity decreased. A significant increase in the compressive strength was observed.

CONCLUSION FROM LITERATURE REVIEW

- ❖ Compressive strength and split tensile strength have shown that copper slag is superior to corresponding control concrete.
- ❖ The results of compressive, split tensile strength test have indicated that the strength of concrete increases with respect to the percentage of slag added by weight of fine aggregate up to 40% of additions and 15% of cement.
- ❖ Water absorption of S40 copper slag concrete specimens is 22% lower than the controlled specimens.
- ❖ Water permeability in concrete reduced up to 40% replacement of copper slag with that of sand.
- ❖ As per ASTM C642, the value obtained for copper slag admixed concrete is graded under the category “very low”. As such, it is indicating lesser permeability of slag admixture concrete. The important observation is that addition of slag definitely reduces the pores of concrete and makes the concrete impermeable.
- ❖ Since copper slag concrete exhibits good durability characteristics, it can be used as an alternate to fine aggregate and also be utilized in cement as a raw material for making blended cements.

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Conflict of Interest

None of the authors have any conflicts of interest to declare.

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