Copper Slag

V.M. Illayaraja Muthaiyaa [1*], G. Elatharasan[1], A. Krishnamoorthy[2]
1* Department of Mechanical Engineering, University college of engineering Pattukkottai, Tamil Nadu
2 Mountzion college of engineering Thirumayam- Tamil Nadu

ABSTRACT

Copper slag is an industrial by-product material produced from the process of manufacturing copper. It has been estimated that approximately 24.6 million tons of slag are generated from the world of copper industry. Although copper slag is widely used in the sand blasting industry and in the manufacturing of abrasive tools, the remainder is disposed of without any further reuse or reclamation. Copper slag possesses mechanical and chemical characteristics that qualify the material to be used in concrete as a partial replacement for Portland cement or as a substitute for aggregates. An attempt has to be made study compressive strength and flexural behavior of copper slag with recron fiber replaced concrete when compared with the conventional concrete **Keywords:** Copper Slag, Cement, Chemical characteristics, Mechanical and Physical Properties

INTRODUCTION

Currently India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization. In the construction of buildings and other structures concrete plays the rightful role and a large quantum of concrete is being utilized. River sand, which is one of the constituents used in the production of conventional concrete, has become highly expensive and also scarce. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from industrial waste. It was well recognized for many years the beneficial utilization of some industrial by-products in improving the properties of fresh and hardened concrete. By-products such as pulverized fly ash, silica fume and Ground Granulated Blast furnace Slag (GGBS) are added in different proportions to concrete mixes as either a partial substitute to Portland cement or as an admixtures. Concrete prepared with such materials showed improvement in workability and durability compared to normal concrete and has been used in the construction of power and chemical plants and under-water structures. Use of some waste materials has been well documented in design specifications. New by-products and waste materials are being generated by various industries, dumping or disposal of these materials causes environmental and health problems.

MATERIALS AND METHODS

In general, concrete is a mixture of cement, fine aggregate, coarse aggregate and water. And for modifying the properties of concrete as desired, admixtures are added during the preparation of concrete.

Cement: Ordinary Portland cement (OPC) is by far the most common type of cement. OPC is divided into 33, 43 and 53 grades as per IS 269:1989, IS 8112:1989 and IS 12269:1987. The main function of all the types of cement will be binding of aggregate Cement conforming to IS 12269:1987, Ram co OPC -53 grades cement is considered.

Fine Aggregate: The fine aggregates used for the entire specimen were natural river sand complying with the requirements of IS 38:1970. Sieve analysis was conducted using 2.6mm and it was found that sand was conforming to zone II grading. To produce workability and uniformity. To assist the cement paste to hold the particles of coarse aggregate in suspension and to prevent paste to hold the possibility of segregation. To fill up the voids in coarse aggregate. Angular grained sand is to be preferable to round grained sand since it provides good interlocking properties. Aggregates size is in between 150 microns to 4.75mm. The important function of fine aggregate in concrete is

1. To produce workability and uniformity.
2. To assist the cement paste to hold the particles of coarse aggregate in suspension and to prevent paste to hold the possibility of segregation.
3. To fill up the voids in coarse aggregate. Angular grained sand is preferable to round grained sand since it provides good interlocking properties.

Coarse Aggregate: Corse aggregate is gives a body to the concrete reduce shrinkage and effect economy. This occupies major volume of concrete. Generally grading of aggregates is followed. Size of aggregates varies from 5mm to 20mm for R.C.C. structures. Crushed natural aggregates are used as coarse aggregates. These aggregates are tested for compacted and loosened bulk density. Sieve size of 20mm aggregates are used in equal proportion. The strength of concrete depends on coarse aggregate. It should be hard, strong, dense, durable, rough and free from salt, alkali and organic matters. Blue organic, gneiss, crystalline lime stone or good sand stone are crushed in to small pieces of size varying from 5mm to 20mm are generally used as course aggregates. Coarse aggregates with a nominal maximum size of 20 mm is to be used in this study

Water: Water used for mixing and curing of concrete shall be clean and free of oils, acids, alkalis, salts, sugar, organic material etc. Potable water is to be generally considered satisfactory for mixing concrete. PH value of 7 will be preferred.

Copper Slag: It is a by product obtained during refining of copper. Production of concrete using copper slag (ground) in place of cement (partial replacement) gives strength. It has good pozzalonic properties. It is obtained from STERLITE INDUSTRIES LTD, Tuticorin

Recron Fibre: Recron fibre is a triangular Polyester Fibre in cross section with cut length of 12mm is to be. Fibre does a small piece of material possess certain characteristics properties. They can be circular, triangular or flat in cross section. The fibre is often described by a convenient parameter called “aspect ratio”. The aspect ratio of the fibre is the ratio of its length to its diameter.

MIX DESIGN

Mix design for M20 grade concrete according to IS method

1. No replacement (conventional) 100% cement + 100% FA + CA.
2. 20% (by weight) replacement of sand with copper slag 80% sand +20% copper slag + cement + CA.
3. 30% (by weight) replacement of sand with copper slag 70% sand + 30% copper slag + cement + CA.
4. 40% (by weight) replacement of sand with copper slag 60% sand + 40% copper slag + cement + CA.
5. 50% (by weight) replacement of sand with copper slag50% sand + 50% copper slag + cement.

RESULTS & DISCUSSION

Mechanical properties: Testing of hardened concrete plays an important role in controlling and conforming the quality of cement concrete work. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control programme for concrete, which helps to achieve higher efficiency of the materials used and greater assurance of the performance of concrete with regard to both strength and durability. The test methods should be simple, direct and convenient to apply. One of the purposes of testing hardening concrete is to confirm that the concrete takes time, one will not come to know, the actual strength of concrete for some time. This is an inherent disadvantage in conventional test. But, if strength of concrete is to be known at an early period, accelerated test can be carried out to project 28 days strength. But mostly when correct materials are used and careful steps are taken at every stage of the work, concretes normally give the required strength. The rests also have a deterring effect on those responsible for construction work.

Experimental technique:

Testing Procedures: This project entailed subjecting the designed concrete mixes to a series of tests to evaluate the strength. For this project, it was important to monitor the strength development with time to adequately evaluate the strength of each concrete mix. For each test, either 3 samples from each mix were tested at each curing age, and the average values were used for analysis. The following sections present the procedures used for the compressive strength tests.

Compressive Strength Test: The compressive test is used to determine the hardness of cubical and cylindrical specimens of concrete. The strength of the concrete specimen depends upon cement, aggregate, bond, w/c ratio, curing temperature, and age and size of specimen. The compressive strength was determined of cubes of size 150x150x150 using CTM. After 7, 14, 28 days, it should be loaded in the compression testing for machine and tested for maximum load. Compressive strength should be calculated by dividing maximum load by cross-sectional area. The maximum load at failure reading was taken and the average compressive strength is calculated by the following formula **F=P/A**

Here 20%, 30%, 40% & 50% of copper slag was replaced with sand and 0.2%, 0.4%, 0.6% of recron fibre was replaced with cement. Since optimum percentage replacement was obtained at 40% replacement of copper slag with sand and 0.6% of recron fibre replacement with cement, one combination specimen (40% copper slag + 60% sand & 0.6% recron fibre + 99.4% cement) was also cast for determining strength properties. For control concrete the compressive strength was found to be 35.31 N/mm2. Only copper slag mixed concrete the compressive strength obtained was 38.67 N/mm2 for CS40 % concrete. On the other hand 43.07 N/mm2 for CS30% with 0.6% of recron fibre concrete , 51.2 N/mm2 for CS40% with 0.6% of fibre concrete and 46.3 N/mm2 for CS50% with 0.6% fibre concrete after 28 days of curing. The compressive strength of the 40% copper slag and 0.6% recron fibre mixed concrete showed higher strength values than corresponding control concrete. **The maximum percentage of increase in compressive strength** is found to be **45%** at **CS40%** and **o.6% RF**.

CONCLUTION

The result of compression test indicated that the strength of concrete increases with respect to the percentage of copper slag added by weight of fine aggregate up to 40% of additions. The quantity of specimens to be tested and physical properties of Cement, Fine aggregate, coarse aggregate and chemical composition of Copper Slag are suited for the mixture design. Concrete cubes are cast and for compressive strength with 20%, 30%, 40%, 50% replacement of Fine aggregate by copper slag &0.2%, 0.4%, 0.6% Replacement of cement by recron fibre results of the cube & are compared. On economic analysis, it is found that copper slag and recron fibre is economical. It is found that the compressive strength of Concrete Mix (40% replacement of Fine aggregate by copper slag and 0.6% Replacement of cement by Recron fibre gives 45% higher strength than conventional concrete.

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