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Assessment of Behaviour of High Performance Concrete on Incorporation of Waste Materials

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ABSTRACT: Disposal of wastes is one of the issues confronting the world today. Scientists all over the world are making efforts to minimize the production of wastes and to effectively recycle the waste. Reducing the green house gas emission and recycling of industrial wastes are the key areas of concern. Production of wealth will be a boon to the industries as the benefits are twofold: the pollution problem is addressed and the raw material shortage problem is also effectively tackled. Against this back-drop, in the present work, copper slag (CS) and Rice Husk Ash (RHA) is utilized as viable substitutes in concrete. M20 grade concrete with different mix proportion of sand replaced with copper slag from 0 to 70% and 0 to 25% cement replaced with Rice Husk Ash (RHA) and a combination of both (30% CS +10% RHA) is prepared. Tests for strength (compression and split tensile strength), acid resistance test and SEM analysis are carried out. The results of this work undertaken have revealed that peak strength is obtained on 30% replacement of sand with copper slag (45.3N/mm2) and 10% of cement with RHA (38.8N/mm2) and the combined mix gives good strength of 46.5N/mm.2

KEYWORDS: Copper slag, Rice Husk Ash, Compression test, Acid resistance test, waste disposal.

I. INTRODUCTION

Concrete is one of the prime materials for structures and it is widely used for various applications all over the world. The usage of concrete is inevitable throughout the globe. Aggregates and cement play a major role in concrete. In India there is a great shortage of natural aggregates. Recently Tamil Nadu government (in India) has imposed restrictions on removal of sand from the riverbeds due to its threatening effects. Production of cement liberates same amount of carbon dioxide which is the great cause of ozone depletion. This effect creates a question on the sustainability of concrete. In order to make concrete a sustainable material, suitable engineering approaches can be done.

Apart from this waste generation has increased considerably and find no way for disposal. In order to overcome this, industrial and agro- waste materials can be used as alternate building materials. In our present study we made an attempt by utilizing copper slag an industrial waste and RHA an agro waste as suitable substitutes in concrete.

II. RELATED WORK

Brindha.D et al., (2010) The presence of silica in slag is about 26% which is desirable since it is one of the constituents of the natural fine aggregate used in normal concreting operations. 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.

Mobasher.B et al., (1996) This study points out the beneficial aspects of using copper slag as a pozzolanic material. Copper slag is shown to significantly increase the compressive strength of concrete mixtures. Use of lime as a hydration activator was evaluated and shown to improve the rate of strength gain. Results obtained from this study indicate the tremendous potential of copper slag as a mineral admixture.

Pazhani.K et al., (2010) This paper presents an experimental investigation to assess the durability parameters of high performance concrete with the industrial wastes. The slump value for 100% replacement of fine aggregate with copper slag increases by 60mm to 85mm. It shows that the water consumed by the copper slag during mixing is very less as compared with river sand.

Meenakshi Sudarvizhi.S et al., (2011) 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), where as the increase in strength is more or less the same different percentage of CS&FS. The results show that the split tensile strength of CS&FS concrete is increased when compared to control concrete (6.10 MPa to8.65 MPa cured at 90 days), where as the increase in strength is more or less the same different percentage of CS&FS.

Yang HS et al., (2010) "Copper slag with mgo as pozzolanic material, soundness, pozzolanic activity and microstructure development" copper slag has little periclase material. The consumption calcium hydroxide showed the slag exhibits high pozzolanic activity, which has higher than that of flyash.

III. MATERIALS USED

3.1 CEMENT

Cement is a binding material. The raw materials used for the manufacture of cement consist mainly of lime, silica, alumina and iron oxide. Ordinary Portland Cement (OPC) of 53 grades was used for casting all the specimens.

3.2 RICE HUSK ASH

Rice Husk Ash (RHA) is a by-product of the agricultural industry which contains high amount silicon dioxide (Sio2). RHA is obtained by burning rice husk at a temperature ranges between 600˚C and 750˚C. The obtained product is then grained in a ball mill to get fine product

3.3 FINE AGGREGATE

The aggregates which passes through a IS sieve of size 4.75mm is known as fine aggregates. Sand is used as a filler material in concrete and it gives strength to the concrete. The sand is naturally obtained from the gravels and rocks and it should be free from impurities. In this investigation locally available clean and dry Cauvery river sand was used. According to the particle size distribution the fine aggregate has divided into four grading zones. In this test zone II grade sand has been used.

3.4 COPPER SLAG

Copper slag is an industrial byproduct. Copper slag is a glassy granular in nature.its particle size is almost similar to sand so this can be used as a viable substitute for sand.

3.5 COARSE AGGREGATE

The aggregates which are retained on the 4.75mm IS sieve is known as the coarse aggregates. Crushed aggregates with specific gravity of 2.815 and passing through 20mm sieve and retained on 10mm will be used for casting all specimens. Several investigations concluded that maximum size of those aggregates should be restricted in strength of the composite.

3.6 WATER

Casting and curing of specimens were done with the potable water that is available in the university premises.

IV. EXPERIMENTAL RESULTS

4.1 Slump test:

The slump value of all the mixes ranges between 35 and 100.this implies that all the mixes possess good workability. The slump value increases with increase I percentage of copper slag and RHA.

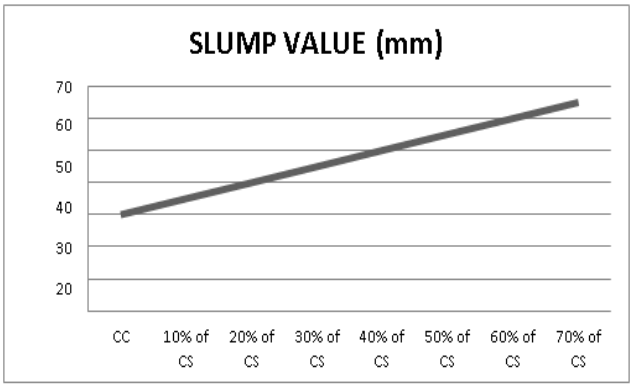

Fig. a: Slump value for copper slag

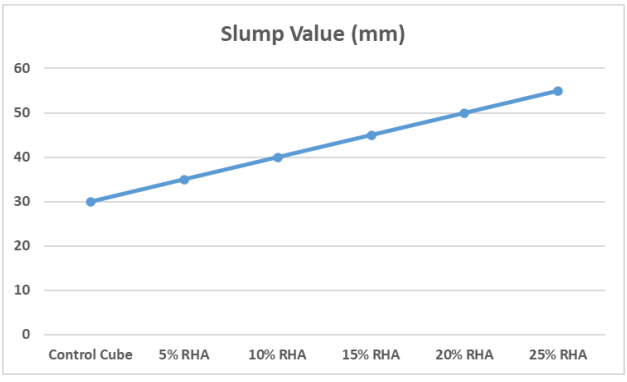

Fig. b: Slump value for Rice husk ash

4.2 Compression Test

For different mixes the compressive strength at different ages 7 , 14 and 28 days were found out. From the above analysis it is observed that optimum strength is obtained at 30% replacement of sand with copper slag. The increment in strength is about 46% compared to control concrete. Anyhow upto 50% replacement compressive strength is higher than control concrete. The results on replacement of 10% RHA on cement shows optimum strength, whereas upto 15% the strength does not go beyond control concrete. The compressive strength of combined mix is 46.8N/mm2.

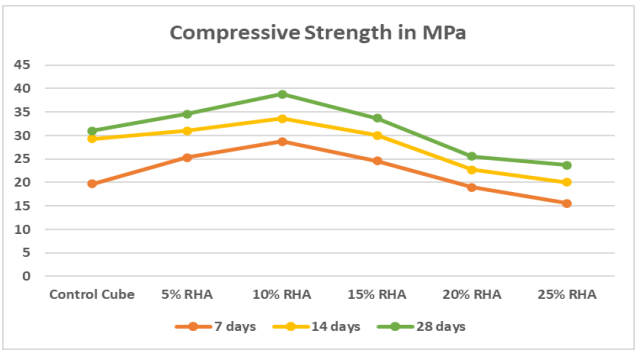

Fig. c: Compressive strength of concrete replaced with copper slag

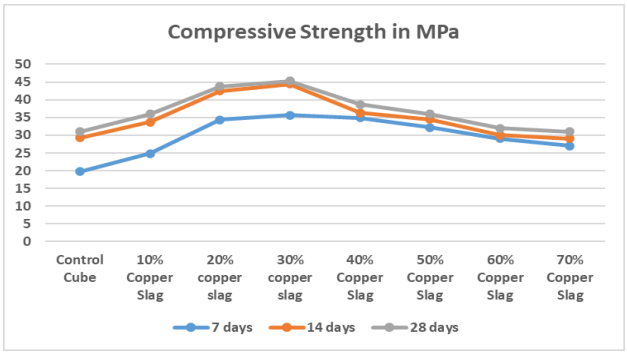

Fig. f: Compressive strength of concrete replaced with RHA

4.3. Split tensile test

The split tensile strength is observed on 28th day. Optimum strength is obtained on 30% replacement of sand with CS is 4.2N/mm2. In case of RHA peak value is 4.1N/mm2 on 10% replacement of cement.the combined mix shows 4.1N/mm2. Optimum strength is obtained on the combined mix is 4.4N/mm2.

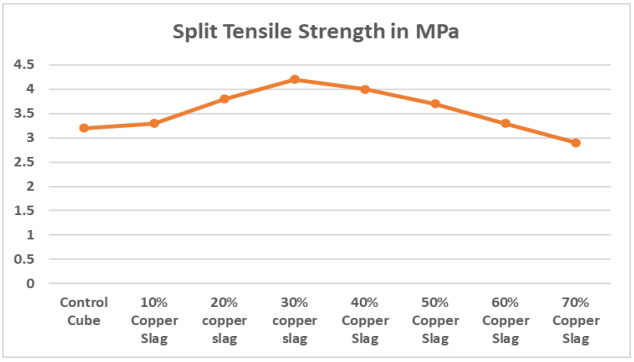

Fig. g: Split tensile strength of concrete replaced with copper slag

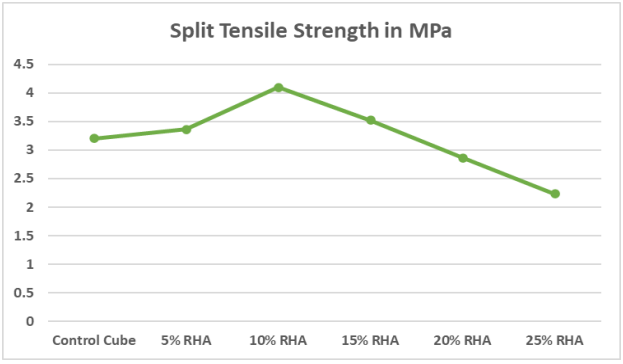

Fig. h: Split tensile strength of concrete replaced with RHA

4.4. Acid resistance test:

From the result of acid resistance test, mixes with high percentage of copper slag shows less resistance to H2SO4 whereas the .mixes containing RHA gives more resistance to acid attack.

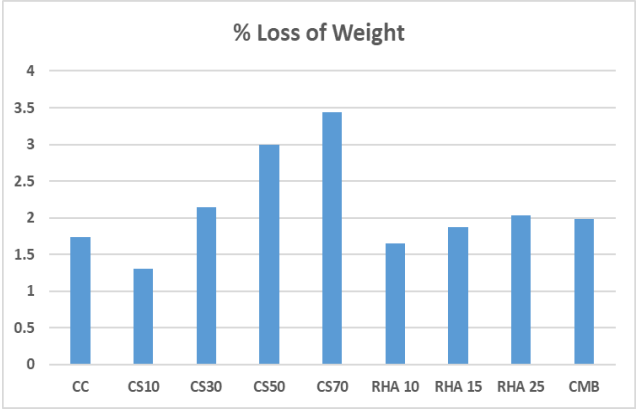

Fig. i: Loss of weight in Acid resistance test

Fig. j: Loss of strength in Acid resistance test

V. CONCLUSION

The physical and chemical properties of waste materials i.e. copper slag and RHA is studied. From the above study the performance of this blended concrete is found to be good. The analysis of the study reveals that the partial replacement of fine aggregate with copper slag and cement with RHA provides additional environmental and technical benefits for all related industries. Further the cost of concrete reduces due to the partial replacement of wastes. This alternate technology assures high strength and high workability concrete is possible at cheaper cost. Additionally it is found that water absorption of blended concrete is found to be less compared to control concrete.

This experimental study reveals that replacement of cement up to 10% gives optimum compressive and tensile strength. However the duration and the temperature of burning and fineness of RHA has more effect on strength .The durability of this blended concrete depends highly on the physical and chemical properties of RHA and CS which may vary according to the condition of regions. Further research is needed to study the durability of this blended concrete.

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