EXPERIMENTAL STUDY ON CONCRETE USING COPPER SLAG AS FINE AGGREGATE WITH BACTERIAL ADMIXTURES

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Abstract— The present investigation is to obtain the performance of the concrete by microbiologically induced special growth. One such has led to the development of a very special concrete known as bacterial concrete where bacteria is induced in the mortars and concrete to heal up the faults. Researchers with different bacteria proposed different concretes .here an attempt was made by using the bacteria "bacillus subtilis". This study showed a significant increase in the compressive strength due to the addition of bacteria. The chemical traces copper , sulphate and alumina present in the slag are not harmful many researchers had already found ,copper slag possible to use as a material in concrete In this experiment study copper slag in concrete as replacement material of fine aggregate. When 60ml, 180ml of bacillus subtilis and 20%, 40% of copper slag is added in M20 grade concrete it attains maximum compressive strength on adding 180ml. In concrete self – healing property is successfully achieved due to addition of bacteria.

Keywords— Bacterial concrete, Bacillus subtilis, Copper slag, Compressive strength.

I. INTRODUCTION

Due to the growth in population, the amount and type of waste material have increased accordingly. It is incredibly versatile and it is used in almost all major construction projects. Aggregate are used in concrete for very specific purposes. Aggregate typically make up about 60% to 75% of the volume of the concrete mixture and as they are the least expensive of the material used in concrete, the economic impact is significant 80% of building CO2 emission are generated not by the production of the material used in its construction, but in the electric utilizes of the building over its life-cycle. Compared to other comparable building materials, concrete is less costly to produce and remains extremely affordable. Waste material like copper slag is a major component of waste stream in many countries. Copper slag is a 100% recyclable material with high performance and unique aesthetic properties which make it suitable for wide-spread uses. The water absorption of 20 mm coarse aggregates, sand & copper slag is determined by conventional method and found to be 1.21, 1.01 and 0.65 respectively. It is found that water absorption of copper slag is very low as compared with the natural sand and its effects on workability of concrete. Results from specific gravity and water absorption tests revealed that copper slag has a specific gravity of 3.30 which is higher than that of sand, whereas the water absorption values for copper slag and sand were about 0.65% and 1.01%, respectively. This suggests that concrete produced with large copper slag substitution would have larger density values than concrete produced with sand alone. On the other hand, due to its low water absorption it is expected that the free water content in concrete mixtures will increase as copper slag content 2 increases. This will lead to an increase in the workability of concrete mixtures containing high copper slag percentage. The water absorption of coarse aggregates, sand and copper slag is shown in Table 2.7. Table 2.8 shows the physical properties of coarse aggregates, sand and copper slag. Table 2.6 Water Absorption for Aggregate Sand Copper slag is used in the concrete as one of the alternative materials. It is the waste product of copper from Sterlite Industries India Ltd, Tuticorin. The safe disposal of this waste is a lack, costly and cause environmental pollution. The construction industry is the only area where the safe use of waste material (**copper slag**) is possible and when it is introduced in concrete as a replacement material, it reduces the environmental pollution, space problem and also reduces the cost. The present investigation is to obtain the performance of the concrete by the concrete by the microbiologically induced special growth. One such has led to the development of a very special concrete known as bacterial concrete where bacteria is induced in the mortars and concrete to heal up the faults. Researchers with different bacteria proposed different concretes .here an attempt was made by using the bacteria "**BACILLUS SUBTILIS (BS)**". This study showed a significant increase in the compressive strength due to the addition of bacteria. The chemical traces copper , sulphate and alumina present in the slag are not harmful many researchers had already found ,copper slag possible to use as a material in concrete In this experiment study copper slag in concrete as replacement material of fine aggregate. When 60ml, 180ml of bacillus subtilis and 20%, 40% of copper slag is added in M20 grade concrete it attains maximum compressive strength on adding 180ml. In concrete self –healing property is successfully achieved due to addition of bacteria. To avoid micro-cracks in concretes, bacteria can be effectively used which is called as impregnated concrete which is recent advancement in concrete technology. In the technique 3 bacteria from bacillus family are impregnate in concrete which are having calcium as their food from concrete and when these bacteria gets in contact with atmosphere they use water and carbon dioxide from surrounding environment. And its produces the precipitate of calcium carbonate (lime stone) which ultimate seals the cracks.

II. LITERATURE REVIEW

The utilization of waste material in concrete production is very much helpful to reach the goal of the sustainable construction. Therefore, in this study copper slag waste is used as replacement for the fine aggregate. Brindha et al., studied on the granulated copper slag as the partial replacement for fine aggregate in the ratio of 0%, 5%, 10%, 30%, 40% and 50%. The compressive strength are observed to increase about 35-40% and split tensile strength by 30-35% and the maximum replacement percentage can be up to 40%. Liya et al made an optimum replacement of 30-60% of the copper slag. Amarnaath and Dinesh studied about the effective replacement of fine aggregate using copper slag from which the maximum compressive strength was found to on 35% of partial replacement of copper slag. Chiara Barabesi et al described about the use of bacillus subtilis geme cluster involved in calcium carbonate bio mineralization and its formation. Marvasi et al explains about the synthesis of exopolymeric substance (EPS) from bacillus subtilis and the implications of calcium carbonate precipitation by microbes in natural environments.

III. MATERIAL PROPERTIES

Cement is a binding material of grade OPC33 is used for the study. The fine aggregate passings through 4.75mm sieve were used. The particle shape of the river sand used in this research was quite irregular in nature. The fine aggregate was brownish in its appearance

for which the sieve analysis, specific gravity, water absorption tests were performed.

Table 1 Properties of cement

TESTS	RESULTS
Specific gravity	3.17
Consistency	35
Initial setting time	28 min
Final setting time	373min
Fines	0.35

Table 2 Properties of fine aggregate

PARAMATERS	FINE AGGREGATE
Particle shape	Irregular
Appearance	Yellowish brown
Type	River sand
Specific gravity	2.67
Water absorption %	1.51
Fineness modulus	2.76

Aggregate of size more than 4.75mm is used for the study. Coconut fibre, is a natural fibre extracted from the husk of coconut. It has the advantage of not sinking. As the diameter of the rope increases the elongation load increases. The coconut fibre rope is done in both ways man made and as well as machine. The machine gives less strength compare than the man made rope because of the tightening between the coir of the rope. Grade of concrete used for this study is M30.

Table 3 Properties of coarse aggregate

TESTS	RESULTS
Specific gravity	2.77
Water absorption%	1.35
Impact value	12.6%
Fineness modulus	2.62

Copper slag is obtained from the Sterlite industries which is the waste material obtained from the copper manufacturing unit.

Table 4 Properties of Copper slag

TESTS	RESULTS	
Specific gravity	3.47	
Water absorption%	1.35	
Fineness modulus	3.3	
Bulk density	Loose state	Compacted state
	1898 kg/m^3	2024 kg/m^3

IV. RESULTS AND DISCUSSION

The compressive strength of the conventional concrete at 7 and 28 days while replacing copper slag of 20 % is 8.8 N/mm^2 and 20 N/mm^2 and also while replacing copper slag to 40% the compressive strength 13.3 N/mm^2 and 21.78 N/mm^2. While in this study the along with copper slag BACILLUS SUBTILIS (BS) was also added at 60 ml and 180 ml. So the comparative results are when there is the addition of 60 ml and 180ml to 20% replacement of copper slag the compressive strength values for 7and 28 days are 12.8, 13.3, 26.67, and 31.1 respectively. Similarly for the addition of 60 ml and 180ml to 40% replacement of copper slag the compressive strength values for 7and 28 days are 15.56, 16.89, 29.32 and 33.32 respectively.

Fig 1 Cube compressive strength

Table 5 Compressive Strength – 20% Copper slag

Table 6 Compressive Strength – 40% Copper slag

BACTERIA (ml)	COMPRESSIVE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
0	8.8	20
60	12.8	26.67
180	13.3	31.1

Fig 2 Comparison of Comresive Strength of copper slag replacement of 20 %

BACTERIA (ml)	COMPRESSIVE STRENGTH (N/mm^2)	
	7 DAYS	28 DAYS
0	13.3	21.78
60	15.56	29.32
180	16.89	33.32

Fig.2 Comparison of Comresive Strength of copper slag replacement of 40 %

V. CONCLUSION

The utilization of copper sag in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of copper slag in fine aggregate reduces the cost of making concrete. The result of compressive strength indicates that the strength of concrete increase on increasing the percentage of

copper slag (40%) and increasing the additive content (Bacillus subtilis- 180ml). On comparing the cost of the cost of copper slag and bacillus subtilis is low so this can be adopted as the self- healing concrete at the place where the environmental effects are higher.

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