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Innovative Use Of Copper Slag In Design Mix Concrete

[1]Deep Thakkar, [2]Kartik Patel

[1]M.E student, [2]HOD

Department of Civil Engineering, Faculty of Engineering, Gokul Global University, Sidhpur, Gujrat.

ABSTRACT:- Sustainability and resource efficiency are becoming increasing important issues within today's constructionindustry. This research study reports the potential use of copper slag as a replacement for sand in concrete mixes. Many countries are witnessing a rapid growth in the construction industry, which involves the use of natural resources for the development of infrastructure. This growth poses a threat to natural resources that are available. Copper slag is considered as waste material and can be used as replacement of fine aggregates. The possibility of substituting natural fine aggregate with industrial by-products such as waste foundry sand and bottom ash offers technical, economic and environmental advantages which are of great importance in the present context of sustainability in the construction sector. The research study investigatedthe effect of copper slag as partial replacement of fine aggregates in various percentages, on concrete properties such as mechanical (compressive strength, flexural strength), and durability characteristics of the concrete.

I. INTRODUCTION :-

Copper slag is a by-product material produced from the process of manufacturing copper. As the copper settles down in the smelter, it has a higher density, impurities stay in the top layer and then are transported to a water basin with a low temperaturefor solidification. The end product is a solid, hard material that goes to the crusher for further processing. Copper slag is one of the materials that are considered as a waste material which could have a promising future in construction industry as partialor full substitute of either cement or aggregates. It is a by- product obtained during the matte smelting and refining of copper. To produce every ton of copper, approximately 2.2– 3.0 tons copper slag is generated as a by-product material. In India copperslag is produced by many industries one of them is Sterlite Industries Ltd (SIL), Tuticorin Tamil Nadu. It is producing Copperslag during the manufacture of copper metal. Currently, about 2600 tons of Copper slag is produced per day and a total accumulation of around 1.5 million tons. If we are able to use the copper slag in place of natural sand then we can successivelyobtain 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

II. SURVEY OF LITERATURE

1. **Al-Jabri et al (2013)** has investigated the performance of high strength concrete (HSC) made with copper slag as a fine aggregate at constant workability and studied the effect of super plasticizer addition on the properties of HSC made with copperslag. There was a decrease in the surface water absorption as copper slag quantity increased up to 40% replacement. Beyond that level of replacement, the absorption rate increases rapidly**. 2. Binayak Patnaik (2015)** studied and an experiment was conducted to investigate the strength and durability properties of concrete having copper slag as a partial

replacement of sand(fine aggregate). Two different types of concrete Grade (M20 & M30) were used with different proportions of copper slag replacement (0 to 50%) in the concrete. Strength and Durability properties such as Compressive strength, Split Tensile Strength& Flexural Strength, Acid Resistivity and Sulphate Resistivity were evaluated for both mixes of concrete. Test results shows that the strength properties of concrete has improved having copper slag as a partial replacement of sand (up to 40%) in concretehowever in terms of durability the concrete found to be low resistant to acid attack and higher resistance against Sulphate attack. **3. Chinmay Buddhadev (2015)** review of innovative use of copper slag and foundry sand in design mix concrete. Thisstudy reports the potential use of granulated copper slag as a replacement for sand in concrete mixes. Copper slag is consideredas waste material and can be used as replacement of fine aggregates. The possibility of substituting natural fine aggregate withindustrial by-products such as waste foundry sand and bottom ash offers technical, economic and environmental advantages which are of great importance in the present context of sustainability in the construction sector. The study investigated the effect of waste foundry sand as partial replacement of fine aggregates in various percentages, on concrete properties such as mechanical (compressive strength, splitting tensile strength and flexural strength) and durability characteristics (rapid chloridepenetration and deciding salt surface scaling) of the concrete**. 4. Meenakshi Sudarvizhi. S, Ilangovan. R (2016)** studied and presented the Performance of Copper slag and ferrous slag as partial replacement of sand in Concrete. The use of Copper Slag(CS) and Ferrous Slag (FS) in concrete provides environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of CS and FS is produced. Owing to the scarcity of fine aggregate for the preparation of mortar and concrete, partial replacement of CS and FS with sand have been attempted. CS and FS are by- products obtained during matte smelting and refining of CS and FS. This work reports an experimental procedure to investigatethe effect of using CS and FS as partial replacement of sand. Six series of concrete mixtures were prepared with different proportions of CS and FS ranging from 0% to 100%. The test results of concrete were obtained by adding CS and FS to sand in various percentages ranging from 0%, 20%. 40%, 60%, 80% and 100%. All specimens were cured for 7, 28, 60 & 90 days before compression strength test and splitting tensile test. The results indicate that workability increases with increase in CS and FS percentage. The highest compressive strength obtained was 46MPa (for 100% replacement) and the corresponding strength for control mix was 30MPa. The integrated approach of working on safe disposal and utilization can lead to advantageous effects on the ecology and environmental also. It has been observed that up to 80% replacement, CS and FS canbe effectively used as replacement for fine aggregate. Further research work is needed to explore the effect of CS+FS as fine aggregates on the durability properties of concrete.

III. RESEARCH METHODOLOGY

we design the mix by IS recommended guidelines. In this project, concrete ingredients are use by locally available materials. However to understand the behavior of this copper slag replaced with fine aggregate in fresh & hardened stage of concrete, the Concrete specimens were tested at different age level for properties of concrete, namely Compression Test, Flexural strength test, Acid attack test, , RCPT (Rapid Chloride Permeability Test), Accelerated corrosion test, Sorptivity, Water absorption test,Chloride attack test, Slump cone test as well different tests regarding to properties of concrete ingredients.

IV. EXPERIMENTAL SETUP

To define the basic characteristics of copper slag and concrete an experimental investigation is carried out to study the followingproperties: compressive strength, modulus of elasticity and durability. The mixture proportions, measurements and test methodused in this study are described in this chapter.

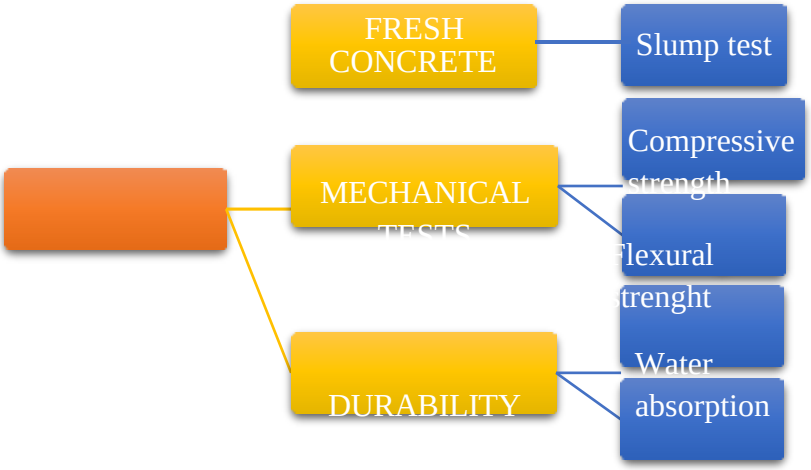
The sample shall be brought to an air-dry condition before weighing and sieving. This may be achieved either by dryingat room temperature or by heating at a temperature of 100 to 110°C. The air-dry

sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.

The sample shall be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket andimmersed in distilled water at a temperature between 22°C and 32°C with a cover of at least 5 cm of water above the top of the basket. Immediately after immersion the entrapped air shall be removed from the sample by lifting the basket containing it25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and aggregate shall remain completely immersed during the operation and for a period of 24 + or - l/2 hours afterwards.

V. EXPERIMENTAL PROCESS

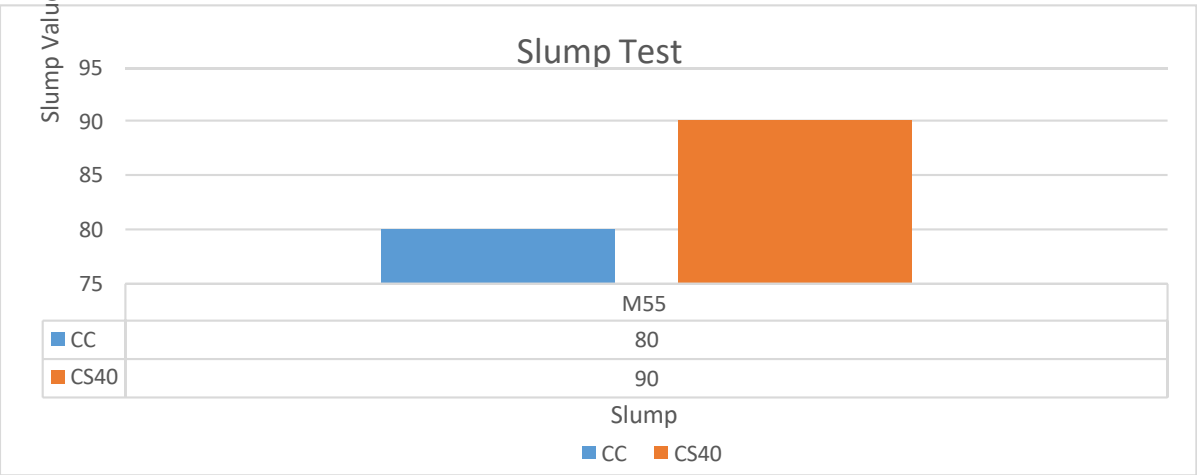
Mixing of concrete is almost invariably carried out by machine, reinforced concrete work and for large scale of concrete work. Machine mix is not only efficient but also economic when large quantity of concrete has been produced. Many type of mixtures are available i.e. batch mixture and continuous mixture, batch mixture produced concrete batch by batch and continuous mixture produced concrete continuously till such time the plant is working. In normal concrete work, it is the batchmixtures that are used. Batch mixtures may be of pan type or drum type. Drum type batch mixture further classify as tilting, nun tilting, reversing and forced action type. In batch mixture material dump batch by batch.


FRESH CONCRETE
Slump test
MECHANICAL TESTS
Compressive strength
Flexural trenght
DURABILITY
Water absorption

VI. RESULT & DISCUSSION

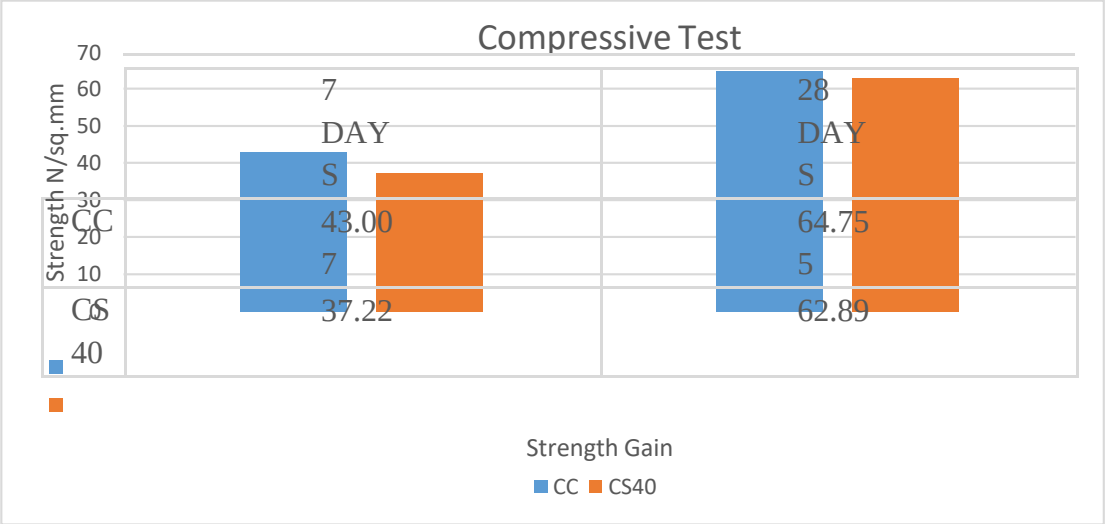
As the title of the investigation program shows, the work is based on the Mechanical and Durability of Concrete with Copper slag replaced with fine aggregate. Here, the results of experimental work are presented in Chart and graphical form. Based on the result obtained, the discussions are carried out as under for different tests.

1. FRESH CONCRETE TEST(SLUMP) :- Fresh concrete or plastic concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement, aggregate and water mixed together to control the properties of concrete in the wet state as well as in the hardened state. Tests adopted for measurement of workability in the present investigation is Slump test. Slump values 90 mm for copper slag replaced (CS40) M55 and 80 mm for conventional M55 which shows good workability of slag replaced concrete than conventional concrete.

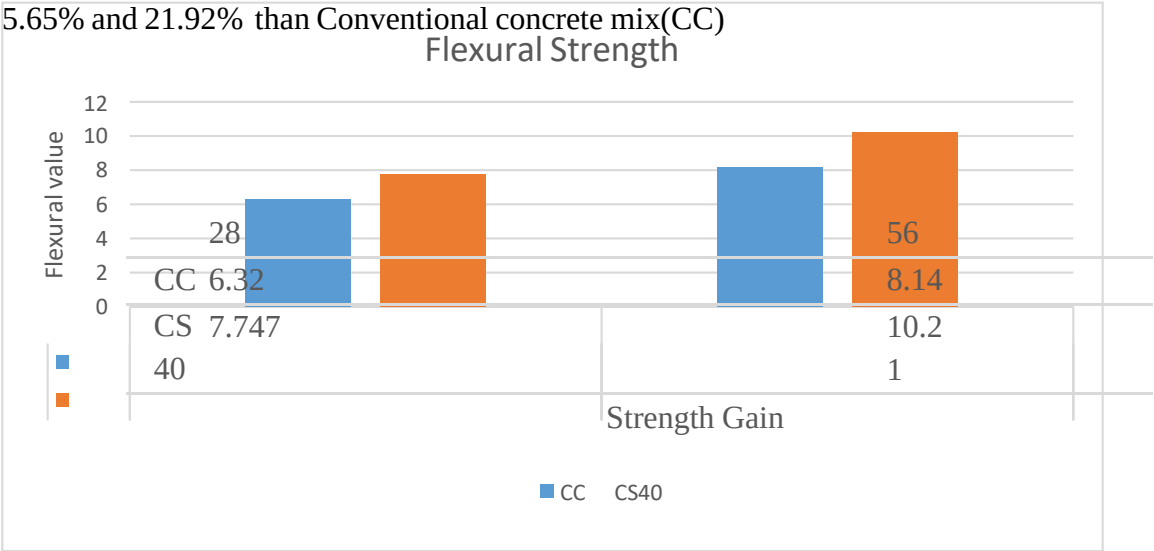


2. HARDEN CONCRETE MECHANICAL PROPERTIES TESTS:-

2.1. COMPRESSIVE STRENGTH TEST:- The compressive strength at the age of 7 and 28 days curing Conventional concrete mix(CC) having 43.007 MPa and 64.755 MPa respectively while in Copper slag replaced with sand 40% (CS40) mix concrete having 37.22 MPa and 62.89 MPa strength which is higher than Conventional concrete mix(CC) but if we consideration results of 56 and 90 days the Copper slag replaced with sand 40% (CS40) mix concrete having 48.35 MPa and
48.62 MPa which is comparatively constant and in Conventional concrete mix(CC) having 41.71 MPa and 43.06 MPa. Result conclude that for M55 grade of Copper slag replaced with sand 40% (CS40) mix concrete 7, 28 days compressive strength increasing respectively 8.63%, 9.71% than Conventional concrete mix(CC).

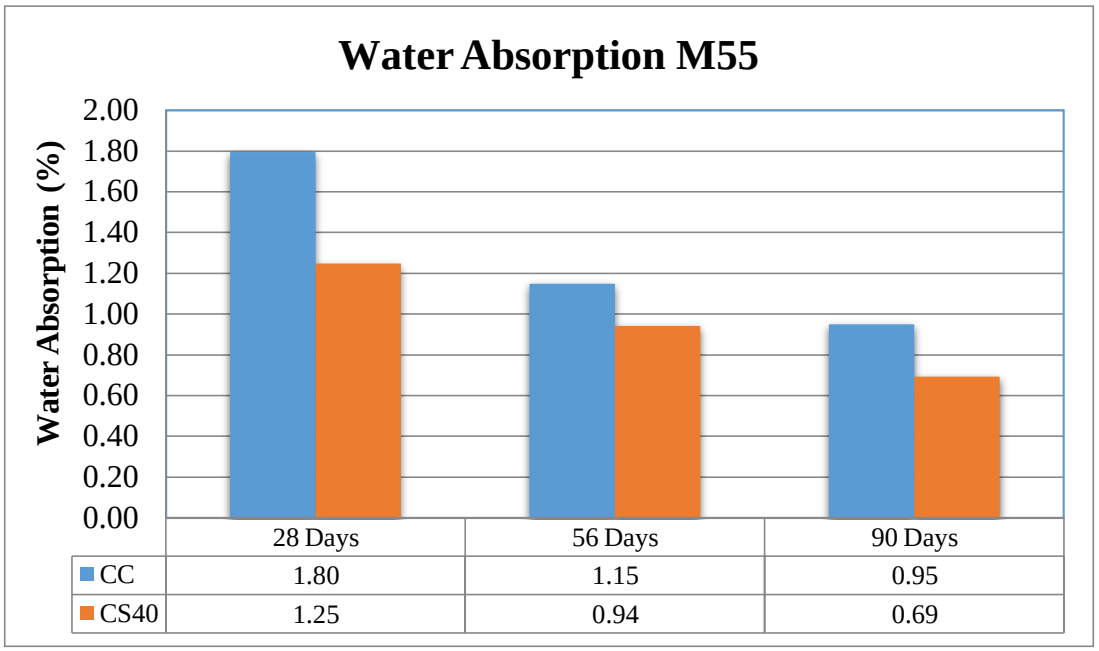


2.2. FLEXURAL STRENGTH TEST:- : For 28 and 56 days CS40 mix concrete have 7.747 MPa and 10.21 MPa andstrength while in CC mix have 6.32 MPa, 8.14 MPa Result conclude that for M55 grade of Copper slag replaced with sand 40% (CS40) mix concrete 28 and 56 days Flexural strength increasing 5.65% and 21.92% than Conventional concrete mix(CC)

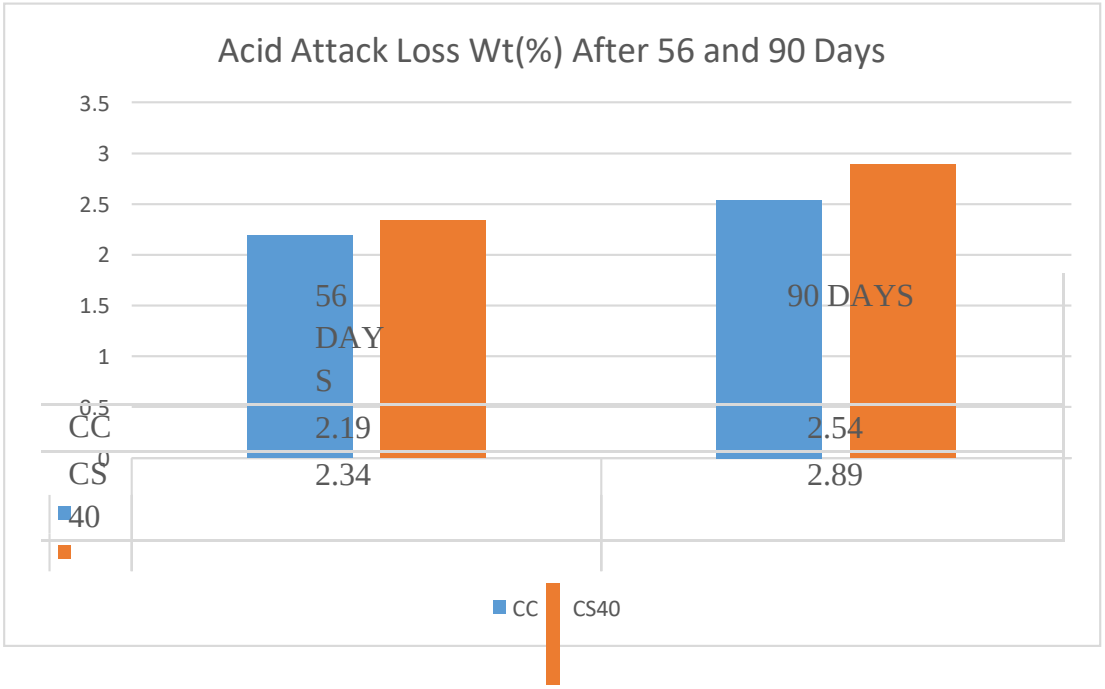


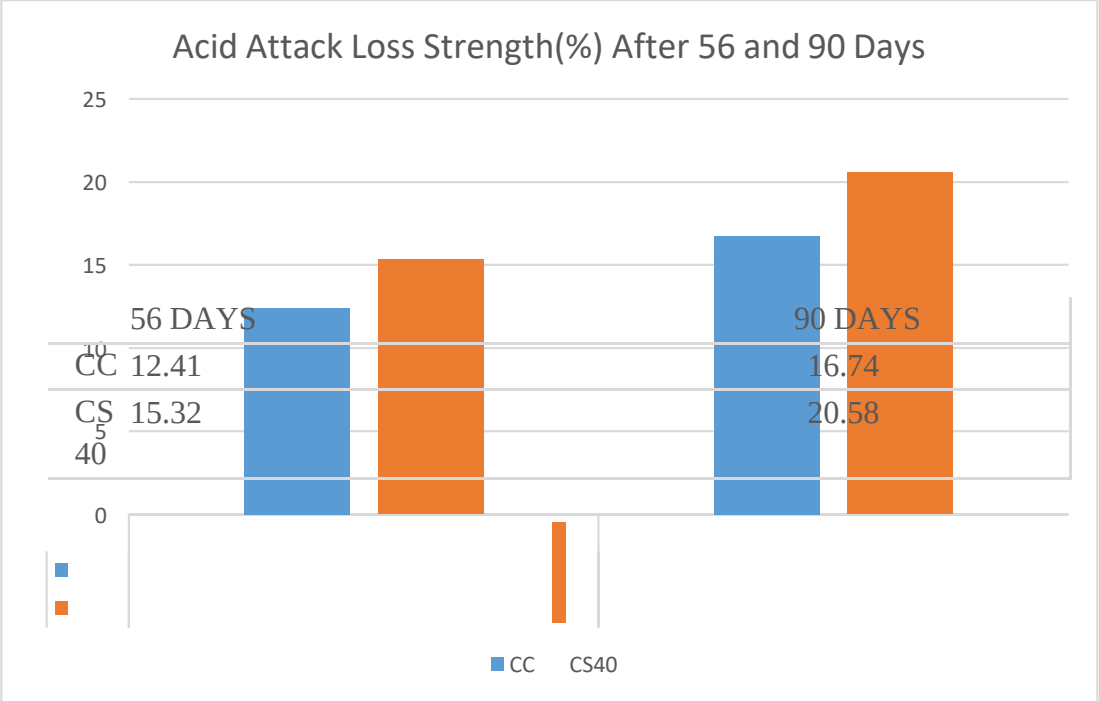
3. HARDEN CONCRETE DURABILITY TESTS:- The durability of concrete is defined as its ability to resist weatheringaction, chemical attack, abrasion, or any other process of deterioration.

3.1. WATER ABSORPTION:- Experimental results for Sorptivity and water absorption of concrete on specimen size of 100 mm dia and 50 mm thick for both types of concretes are shown graph below; The Sorptivity can be determined by the measurement of the capillary rise absorption rate on reasonably homogeneous material. As w/c ratio increases Sorptivity and water absorption increases in all types of concrete



3.2.ACID ATTACK TEST:- The action of acids on hardened concrete is the conversion of ferrous compounds into the ferroussalts of the attacking acid. As a result of these reactions, the structure of concrete gets destroyed. From the test results, the concrete containing copper slag (40%) was found to be lesser in resistance to the H2So4 and HCL solution than the conventional concrete M55 grade. Therefore, the following conclusions were made on acid attack. Conventional concrete specimens showed higher resistance to acid attack than copper slag replaced specimens. The compressive strength of specimensreduced 28.53% for CS40 and 13.47% for CC mix M55 grade concrete and 22.62% for CS40 and 13.11% after 56 days. Therefore it can be concluded that copper slag admixed specimens showed lesser resistance due to acid attack than conventionalconcrete specimens.





VII. CONCLUSION

- M55 grade of Copper slag replaced with sand 40% (CS40) mix concrete 7 and 28 days compressive strength increasing respectively 8.63% and 9.71% than Conventional concrete mix(CC).
- Flexural strength of Copper slag replaced with sand 40% (CS40) mix concrete increasing 5.65%, and 20.92% than Conventional concrete mix(CC).
- Copper slag replaced concrete absorb 0.69% water and conventional concrete absorb 0.95% water after 90 days that shows slag replaced concrete lower water absorption than conventional concrete.
- Acid attack value shows that reduction of weight 2.89% for slag replaced concrete and 2.34% of conventional concrete mix and compressive strength of specimens reduced 15.32% for slag replaced concrete and 20.58% for conventional concrete after56 days.

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