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AN EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY ALCCOFINE AND FINE AGGREGATE BY COPPER SLAG

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Abstract: This research has been done to find out the maximum percentage of Alccofine as partial cement Replacement and Copper Slag as partial replacement of fine aggregate. The construction industries are in the search to find alternative products that can reduce the cost of construction. Demand for cement has been growing every day. In this Research, different Alccofine concretes were developed by replacing 0-18% of Alccofine for cement as practical alternative in place of other hydraulic materials. By using it as an replacing material in form of Alccofine and copper slag in conventional concrete with grade M50, as it is normally used in construction sites. Copper slag is one of the waste materials which can be a promising future in the construction industry as a partial or full substitute of either cement or aggregates just because of its physical similarity to the fine aggregates. For each ton of copper production, about 2.2 tons of copper slag. This slag is currently used for many purposes like landfilling, construction of abrasive tools, roofing granules, cutting tools, and railroad ballast material, which are not very high-value-added applications. The Copper Slag is replaced with sand in the percentage of 0% to 66%. Result shows that the Alccofine and copper slag replaced with Cement show positive results. Workability reduces with increasing % age of Alccofine and copper slag. The maximum proportion of replacement has been found by conducting the following strength tests: Compressive strength test, Flexural strength test and Split Tensile Strength Test

Keywords: ALCCOFINE, Copper Slag, Compressive Strength, Split Tensile Strength, Flexural Strength

1. INTRODUCTION

Concrete is the gradually used development material in this planet. Globally its consumption is approximately two tonnes per year. It is the backbone of every country for its development work. The quality being used here may experience diverse revolution ozen egg yolk to Europe, Japan, and other countries. It ranges from 60 to 100 N/mm2. This type of concrete can resist high loads that normal-strength concrete cannot. The main applications that are in-situ concrete construction in columns are multi storey buildings, offshore structures, bridges having longer span & highway structures. Higher strength could be attained by making optimum use by fundamental ingredients that adds up the material required. Moreover, the selection of the good quality materials, water cement ratio, gen admixtures are required for the development of HSC. ACI has defined HPC in which a high-quality concrete is made by appropriate materials acc. to mix design; properly mixed, transported at site, placed and compacted and cured so that it gives outstanding performance viz conventional concrete.

1.1 COPPER SLAG

The optimum use of industrial waste or secondary material has strengthen the production of cement and concrete in the construction field. There are number of new by products and waste materials are generated by various industries on a large scale. CS also demonstrates pozzolanic. The utilization of CS substitution as cement replacement in concrete, for instance, ordinary Portland cement substitution in concrete, or the dual benefit of eliminating the cost of disposal, and lowering the cost of the concrete.

1.2 ALCCOFINE

Alccofine is a new generation's much awaited material which is much finer then most of other materials used in construction work that are used in our country. It has rare property to improve & maintain the performance of concrete in all stages ranges from fresh to hardened one. It could be used as practical alternative in place of other hydraulic materials. It is mainly manufactured in some kind of special conditions with the help of some special equipment that are used to manufacture the desired size of particle distribution that is its rarest property. Alccofine1203 and Alccofine1101 is of 2 different kinds which has different property from other respectively. GGBS is a non-metallic creation comprising basically of aluminates and silicates & other bases.

2. LITERATURE REVIEW

PJ. PATEL. et al, 2013 Did the detail study on compressive & flexural Strength of High-Performance

Concrete including alccofine as well as fly ash also. Trial of comp. strength was done for almost 90 days as uppermost comp. strength achieved was 78.58 N/mm2 for mix, which is more than aimed strength. Gaining up to 7 days was excellent in every proportions, b/w 7 days to 28 days as gaining of strength is comparatively less, but b/w 28 days to 56 days gaining of strength more because of fly, ash. Slump came out to be extra then 150 mm for each & every mixtures.

In August 2014, Praeen Nayak S. et, al. compared the concrete property which are in hardened stage made with mixture of S.F. & alccofine & staging ideal technique was used for comparable study. The study which done states that the compressive & flexural strength of alccoofine mixture with concrete was far better then micro-silica mix. Effectiveness of micro-silica mixture turned out to be merely higher to alccoofine.

Al-Jabri, K.S., Abdullah, H., Al-Saidy and Ramzi Taha (2011) has done their research study on the Effect of copper slag as a fine aggregate on the properties of cement mortars and concrete and observed more than 70% improvement in the compressive strength of mortars with 50% copper slag substitution in comparison with the control mixture and observed almost 5% increase in the concrete density, when copper slag was used as a sand replacement, whereas the workability increased substantially with an increase in copper slag content and finally come into the conclusions that the copper slag in the range of 40–50%, can replace sand in concrete mixtures.

Deval Soni et, al. (2013) performed & look out on HPC (High Performance Concrete), developed by combination of alccofine & fly ash in ideal proportion. The study came to end that the mixing of 8% alccofine & 16% fly ash was discovered out to be an ideal proportion of H.P.C. Alccofine was found to have better presentation as well as workability when collate to other supplementary cementitious materials such as micro silica, GGBFS etc.

3. MATERIALS

3.1 CEMENT OPC is the most ordinary type of cement is generally used around the world as per basic ingredients of concrete, mortar and mostly no specially grout. It is a fine powder produced by heating materials to form clinker. After grinding the clinker, we would add some small amounts of remaining parts of ingredients It comes to different grades of cement, the 53 Grade OPC Cement provides frequently higher strength compared to others. As per the Bureau of Indian Standards (BIS), the grade no. of a cement highlights the min. compressive strength that cement is expected to attained within 28 days. For 53 Grade OPC Cement, the min. compressive strength achieved by the cement at the end of the 28th day shouldn't be less than 53MPa or 530 kg/cm2. The color of OPC is grey color and by eliminating ferrous oxide during manufacturing process of cement we would get white cement also. Ordinary Portland cement (OPC) of grade 43 of brand Ultra Tech will be used for all concrete mixes.

3.2 FINE AGGREGATES Natural sand is being used here as fine aggregate. Source of natural aggregates was local village nearby to the site of testing. To determine the zone of sand, Sieve analysis will be done as per recommended in the IS code. To find the properties of natural sand like specific gravity, fineness modulus were also carried out.

3.3 COARSE AGGREGATES The particles which retains on the sieve and are larger than 4.75mm are referred to as coarse aggregates. Crushed aggregates, angular in shape are utilized here in experimental work. Coarse aggregate & its grading is being done here as accordingly given in IS: 383-1970. Aggregate of size 10 mm are used. The water absorbing & Specific gravity of aggregate is also carried out as acc to IS 2386 (PART –3)-1963.

3.4 COPPER SLAG

S No	Composition	Results
1.	Fe (FeO or Fe_3O_4)	30-40%
2.	SiO_2	35-40%
3.	Al_2O_3	Upto 10%
4.	CaO	Upto 10%

Table -1: Chemical composition of copper slag (CS)

3.5 ALCCOFINE

Constituents	Composition
Sio2	35.30
MgO	06.20
AL2O3	21.40

Table -2: Chemical properties of Alccofine

4. METHODOLOGY

4.1 CASTING In order to test compressive strength of concrete, concrete specimens of standard cubical mould of size 150*150*150mm were casted in eleven different batches having different replacement percentage of Rice Husk Ash and ESP. The specimen used for this test is cylindrical and its dimension is 150mm in diameter and 300mm in length. The test is made on the beam of size 700 mm× 150mm × 150mm.

4.2 CURING all the materials when mixed adequately to achieve homogeneous mixture. After mixing the concrete was

checked for required slump and then filled into moulds of required tests. The mould filled with concrete was compacted by table vibrator to achieve proper compaction. Mould surface was finished with trowel and date of casting with mix designation number is marked on it. The concrete specimens were then removed from moulds after 24 hours and then placed in curing tanks for curing process for 7 and 28 days at normal room temperature.

4.3 SLUMP CONE TEST It can be used in site as well as in lab. This test is not applicable for very low and very high workability concrete. It consists of a mould that is in the form of frustum having top diameter of 10cm, bottom diameter of 20cm and height of 30cm. The concrete to be tested if fitted in the mould in four layers. The each is compacted 25 times with the help of tamping rod. After the mould is completely filled it is lifted immediately in the vertically upward direction which causes the concrete to subside.

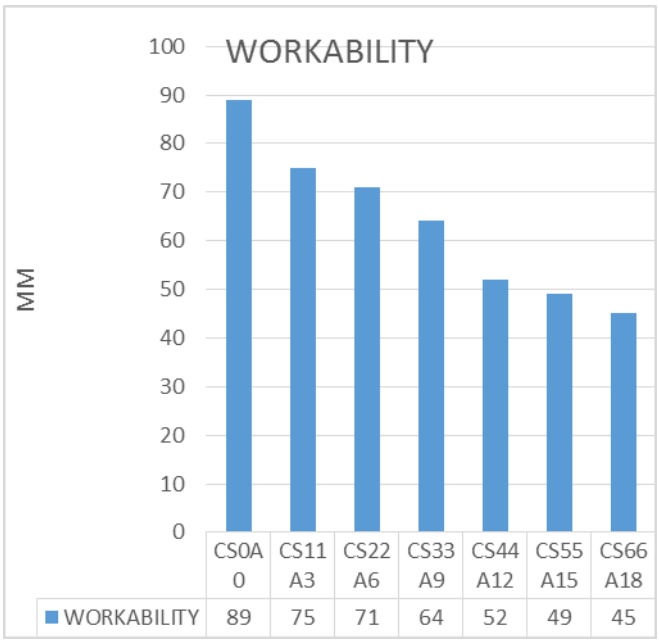

Fig -1: **SLUMP CONE TEST**

4.4 COMPRESSIVE STRENGTH TEST

Then fresh concrete is filled in mould in 4 layers and after filling each layer tamping should be done 35 times in case of cube and 25 times in case of cylinder by using standard tamping rod. Once the mould is filled then leveled top surface of concrete with trowel. After the day the mould will removed and specimen are dropped in the curing tank under standard temperature of 27±2° c. After 7 and 28 days in this research.

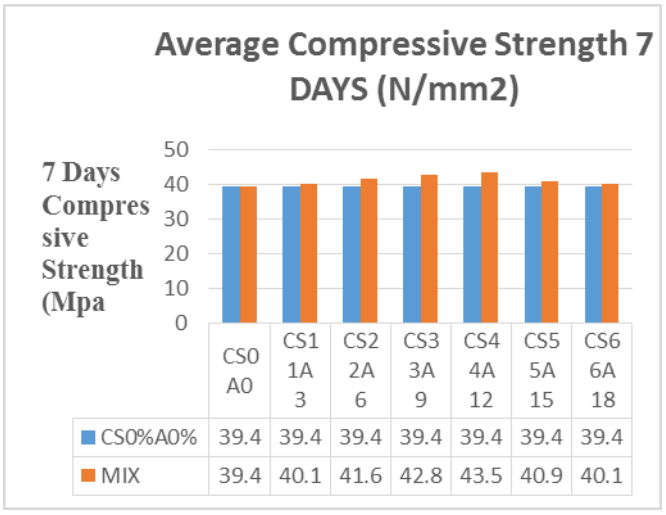

Fig -2: **COMPRESSIVE STRENGTH TEST 7 days**

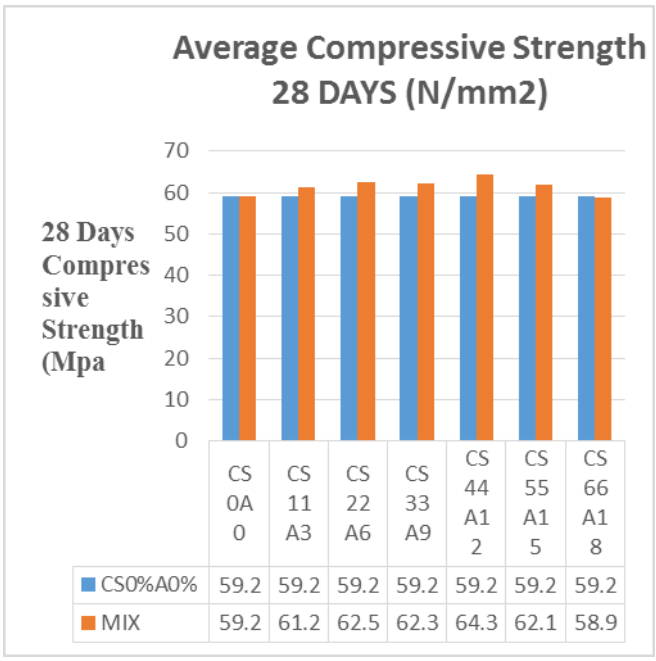

Fig -3: **COMPRESSIVE STRENGTH TEST 28 days**

4.5 SPLIT TENSILE STRENGTH

The specimen used for this test is cylindrical and its dimension is 150mm in diameter and 300mm in length. The instrument used for this testing is universal testing machine. The fresh concrete is prepared in according to the required grades and respective mix proportion. The fresh concrete is filled in mould in layers and each layer is tamping with standard tamping rod with 25 blows for each layer. After the day the mould is removed and specimen is placed in the curing tank for 7 and 28 days in this research at the temperature 27+ 2°c. Then draw the line on the specimen

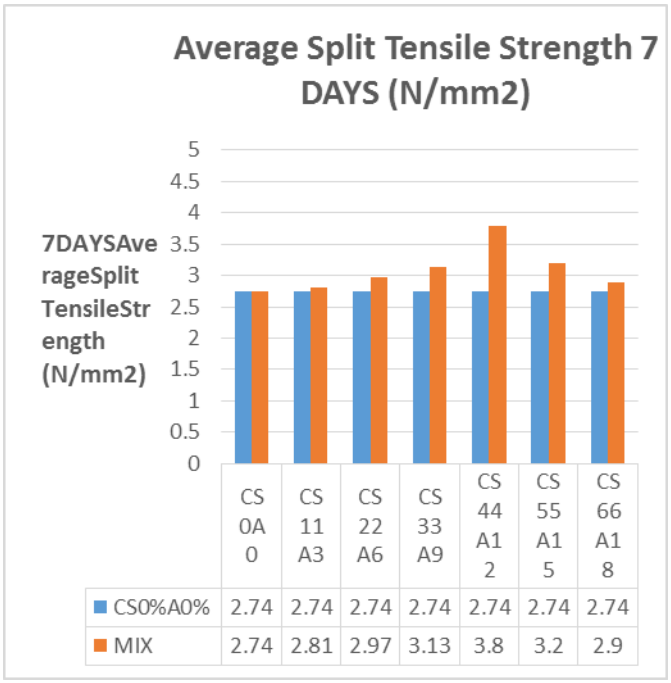

Fig -5 SPLIT TENSILE STRENGTH 7 days

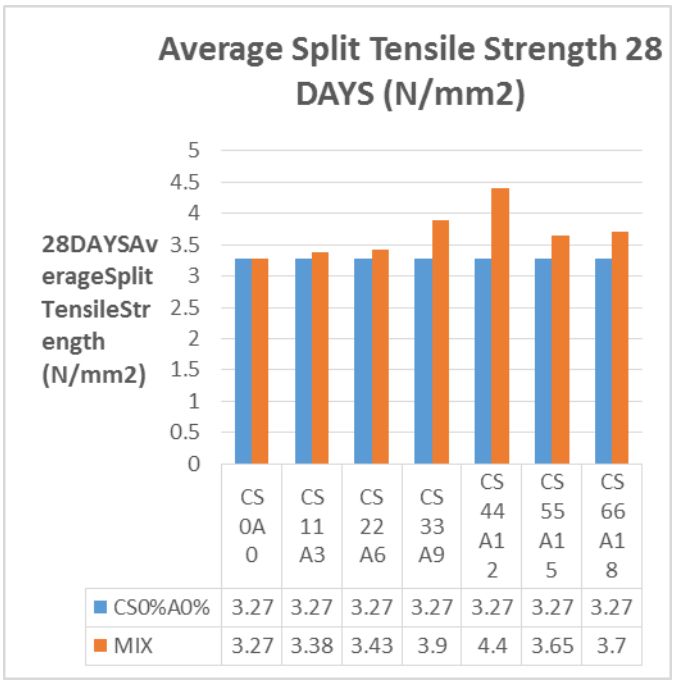

Fig -6 SPLIT TENSILE STRENGTH 28 days

4.6 FLEXURAL STRENGTH TEST

The concrete is prepared at required rate of mass element the mould is filled with concrete in layers and blows 25 times with standard tamping rod. After the day or we can say 24 hours the mould is removed and specimen placed in the water tank for curing at a temperature of 27 + 2 C. Depending upon the requirement the test specimen is removed from the water tank and wipe it properly for 7 and 28 days for testing.

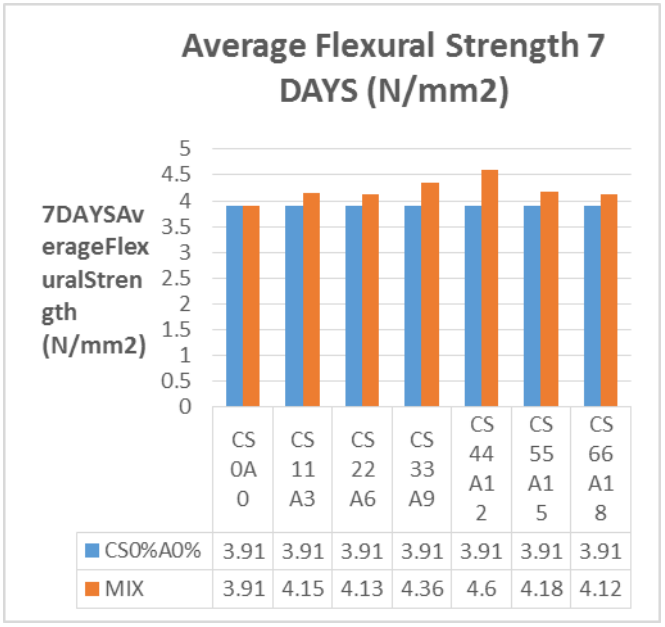

Fig -8 FLEXURAL STRENGTH 7 days

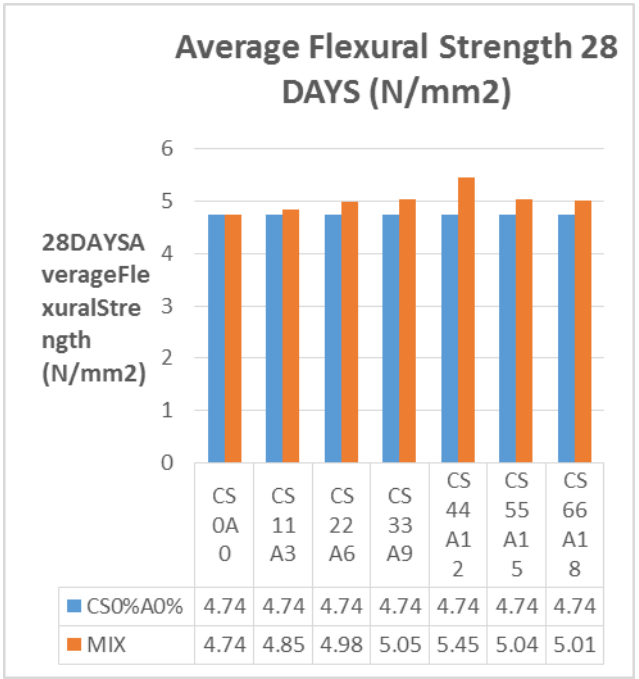

Fig -9 FLEXURAL STRENGTH 28 days

5. CONCLUSIONS

- The outcome of workability by Slump test method concluded that workability reduces with increasing % age of Alccofine By partial replacement of cement and copper slag by fine aggregates. This may be due

to water demand raises with raising % age Alccofine and copper slag.

- The Compressive strength results show that Alccofine By partial replacement of cement and copper slag by fine aggregates, there is increase in compressive strength but aggregates in higher volume decreases strength. After Alccofine and copper slag volume addition and replacing Cement, there is decrement of compressive strength.

- The excellent substitution % age of Railway concrete sleepers and Egg shell powder in terms of strength and economy is CS44%A12%. The value of Compressive strength obtained at optimum percentage substitution is 64.30MPA which is 8.61% higher than normal Mix.

- The split tensile strength and flexural strength or modulus of rupture shown same nature as that of compressive strength or toughness strength

- The use of Alccofine and copper slag in civil engineering works will reduce environmental pollution, upgrade quality of concrete, and reduce its cost of production.

- The partial replacement of the Alccofine By partial replacement of cement and copper slag by fine aggregates has shown +ve impact on split tensile strength up to CS44%A12% substitution.

- The highest value of tensile strength was obtained at CS44%A12%replacement which is 4.40Mpa.

- The flexure strength also showed maximum strength when CS44%A12%is being replaced by Alccofine By partial replacement of cement and copper slag by fine aggregates, increased the strength is 5.45MPA at 28th day. Both help in increasing strength at low volume replacement

- The excellent of favourable substitution % age of Alccofine and copper slag in terms of strength at 28 days and economy is CS44%A12%.

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