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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE WITH CERAMIC POWDER AND COPPER SLAG

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ABSTRACT—Concrete is a homogeneous material which is formed by mixing of Cement Sand and Aggregate in presence of water. Generally cement is used as binder material and sand as filler material which occupies the voids between aggregate. Aggregate is the most common material in concrete and it occupies more than 70-80% of total volume in concrete and it provides strength to the concrete. Now a days due to huge demand of concrete in construction work it is essential to developed or find such sources or material which can replace sand and aggregate in concrete. As aggregate is most common material in concrete and it is acquired from crushing of stones in stone queries which requires huge manpower and mechanical equipment. While crushing of stones it produces very small dust particles having less density and get easily mixed with air which creates adverse impact on environment as well as on the health of the workers at the sight. Concrete is a homogenous mixture of Binder (Cement), Fine aggregate and Coarse aggregate with adequate water – cement ratio.

Keywords—Cement, Fine Aggregate, Coarse Aggregate, Ceramic powder, Copper slag, Concrete

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I.INTRODUCTION

It is one of the prime materials used for the construction. Concrete has good compressive strength and they are weak in tension, reinforcements are designed and added to improve the tensile properties of concrete. Portland cement is most commonly used and they are the basic ingredient of concrete. Cement is manufactured through a closely controlled chemical combination of calcium, silicon, aluminium, iron and other ingredients. Portland cement gets its strength from chemical reactions between the cement and water. The process is known as hydration. It has become important to find a suitable alternative for sand at the same time, it should be cost effective. Manufactured sand is being used off late for the replacement of sand and also Copper slag is being used in sand as well as partial replacements.

CEMENT

The cement used for this work is OPC of 43grades. The specific gravity of cement was tested as per IS: 8112 and was found to be 3.15.In this research cement used OPC 43 grade confirming to IS: 8112. The physical properties of the cement obtained on conducting appropriate are IS: 10262-2009. A cementations material is one that has the adhesive and cohesive properties necessary to proper bond inert aggregates into a solid mass adequate strength and durability.

FINE AGGREGATE

Fine aggregate or sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of grain or particle, but is distinct from clays which contain organic minerals. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Fine aggregate are material passing through an IS sieve that is less than 4.75 mm. Usually natural sand is used as a fine aggregate. At places where natural sand is not available crushed stone is used as a fine aggregate. The sand used for the experimental work was locally procured and conformed to grading zone II. The sand was first sieved through 4.75 mm sieve to remove any particle greater than 4.75 mm sieve and then washed to remove dust. According to IS 383: 1970 the fine aggregate is being classified in to four different Zone-I, Zone-II, Zone-III, Zone- IV. In the present investigation, the river sand, which was available at Cochin, was used as fine aggregate and the following tests were carried out on sand as per IS: 383- 1970. The results of the tests on fine aggregate.

COARSE AGGREGATE

Those particles that are predominantly retained on the 4.75mm sieve are called coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of coarse aggregate. Locally available coarse aggregate having the maximum size of 20 mm was used in the present work. According to IS 2386-1963 coarse aggregate maximum 20mm coarse aggregate is suitable for concrete work. But where there is no restriction 40mm or large size may be permitted. In case of close reinforcement, 10mm size can also be used.

WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked in to very carefully. matter, silt, oil, sugar, chloride and acidic material as per the requirements of water for concreting and curing. Portable water is generally considered satisfactory. In present investigation, tap water was used for both mixing and curing purpose.

CERAMIC POWDER

A ceramic is an inorganic, non-metallic solid comprising metal, non-metal or metalloid atoms primarily held in ionic and covalent bonds. Powdered form of Ceramic raw materials is called as Ceramic Powder and there are several types of Ceramic powder that are available. Ceramics are generally made by taking mixtures of earthen elements, powders and water and shaping them into desired forms. Once the ceramic has been shaped, it is fired in a high temperature oven known as a kiln. Ceramics are covered in decorative, waterproof, paint like substances known as glazes.

Fig.1. CERAMIC POWDER

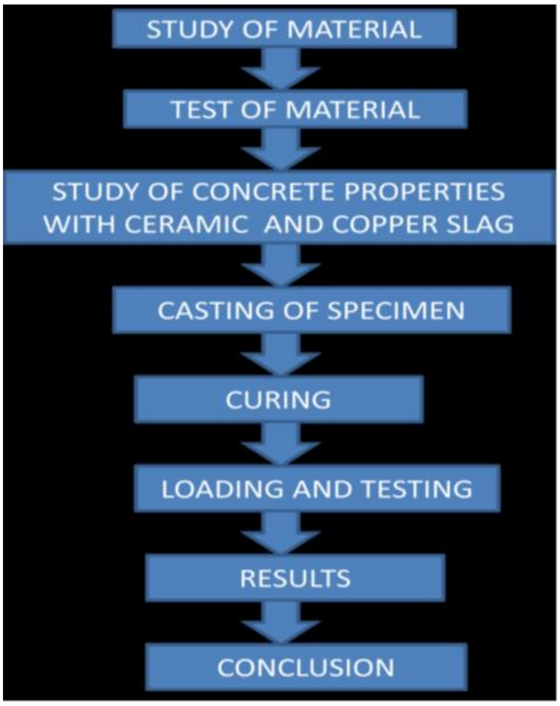
COPPER SLAG

Copper slag is a by-product created during the copper smelting and refining process. The slag serves as a fine or binding agent, which helps hold the larger gravel particles within the concrete.

The present investigation, the crushed waste glass and RCA was used for the following tests

COPPER SLAG

METHODOLGY



MIX RATIO

Mix ratio is 1: 1.56: 2.68

MATERIAL PROPERTIES

MATERIALS

SPECIFIC GRAVITY OF CEMENT

Specific gravity of cement =40-25=15
Weight of equal volume of water=4.8
Specific gravity =15/4.8
Specific gravity of cement =3.1

SPECIFIC GRAVITY OF FINE AGGREGATE

Specific gravity of dry sand =100
Weight of equal volume of water =38
Specific gravity=100/38
Specific gravity of fine aggregate =2.65

SPECIFIC GRAVITY OF COARSE AGGREGATE

Specific gravity of coarse aggregate =(w2-w1)/(w4-w1)-(w3-w2)
Weight of dry sand =100
Weight of water filling of voids =w3-w2
Weight of water filling of pycnometer =38
Weight of equal volume of water =100/38
Specific gravity of coarse aggregate =2.78

Cement by ceramic powder (10%) and copper slag (10%) as fine aggregate mix given below;

Material	Quantity
Fine aggregate	656kg
Cement	419kg
10% ceramic powder	41.9g
Coarse aggregate	1014.3kg
copper slag	101.4kg

Partial replacement of cement by ceramic powder (20%) and copper slag(20%) as the fine aggregate mix given below;

Material	Quantity
Fine aggregate	656kg
Cement	419kg
10% ceramic powder	83.8g
Coarse aggregate	1014.3kg
copper slag	202.8kg

CASTING OF SPECIMENS

The casting of concrete is done so that the strength of concrete can be measured. After arriving mix ratio, the exact quantities of materials for the mix is were weighed and kept ready before mixing is started. The specimens of cubes and cylinders were casted and tested. Size of 150 X 150 X 150mm standard cubes for compressive strength.

TRAIL MIXES WITH CERAMIC POWDER AND COPPER SLAG

As waste copper slag aggregates and ceramic powder were used. The percentages of trail mixes were listed below
Replacement of Fine Aggregate (FA) Vs Copper slag (CS)

1. 100% F.A
2. 90% F.A + 10% C.S
3. 80%F.A + 20% C.S

Replacement of Cement Vs Ceramic powder (CP)

1. 100%
2. 90% F.A + 10% C.P
3. 80% F.A + 20% C.P

TEST FOR HARDEN CONCRETE

COMPRESSIVE STRENGTH

Remove the specimen from water after specified curing time and wipe out excess water from surface. Take the dimension of the specimen to the nearest 0.2m. Clean the bearing surface of the testing machine in such a manner that the testing machine. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast. Align the specimen centrally on the base plate of the machine. Apply the load gradually without shock and continuously at the rate of 140 kg/cm2 minute till the specimen fails. If record the maximum load and note any unusual features in the type of failure.

Compressive strength = P/A

Where,

P = Maximum lad applied (N)

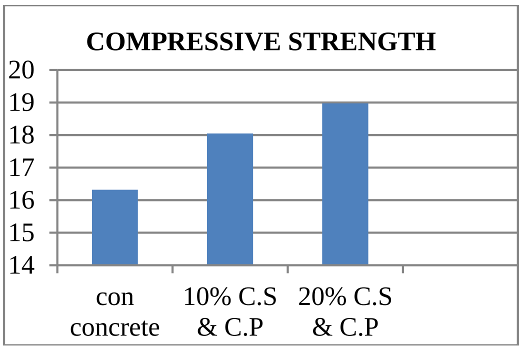
A = Cross sectional area of specimen (mm2)

PERCENTAGE OF TRIAL MIXS

TRIAL MIX	CEMENT	WASTE GLASS COARSE AGGREGARTE	CURING DAYS
TRIAL 1	0%	0%	7days
TRIAL 2	10%	10%	14days
TRIAL 3	20%	20%	28days

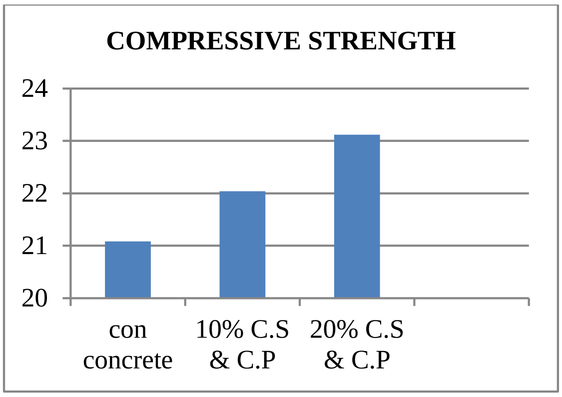
COMPRESSIVE STRENGTH FOR THE CUBE ON 7 DAYS

S.NO	MIX RATIO	COMPRESSIVE STRENGTH (N/mm2)
1	Conventional concrete	16.32
2	10% C.S & C.P	18.05
3	20% C.S & C.P	18.97



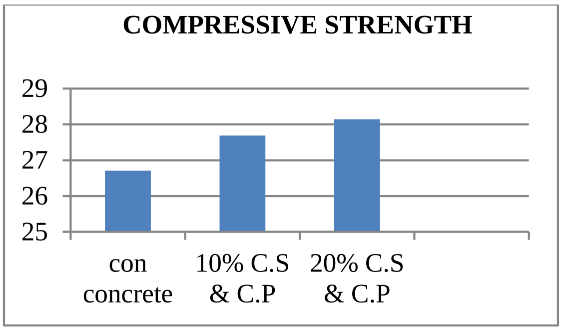
COMPRESSIVE STRENGTH FOR THE CUBE ON 14 DAYS

S.NO	MIX RATIO	COMPRESSIVE STRENGTH (N/mm2)
1	Conventional concrete	21.08
2	10% C.S & C.P	22.04
3	20% C.S & C.P	23.12



COMPRESSIVE STRENGTH FOR THE CUBE ON 28 DAYS

S.NO	MIX RATIO	COMPRESSIVE STRENGTH (N/mm2)
1	Conventional concrete	26.71
2	10% C.S & C.P	27.69
3	20% C.S & C.P	28.14



CONCLUSION

The above experimental data shows that addition of the ceramic powder and Copper slag improves the physical and mechanical properties.

- With this optimum slag level as constant the cement and fine aggregate is replaced with ceramic powder and copper by 10%, 20%, and 30% to have slag increased strength.
- When compared to conventional concrete the replacement of ceramic powder and copper slag at 30% it gives more compressive strength.
- In compression strength, the maximum strength attained is 29.01Mpa at 28days at 30% ceramic powder and copper slag replacement compared to normal M25 grade concrete**.**
- The replacement of cement and fine aggregate with ceramic powder and copper slag gives an excellent result in strength aspect and quality aspect.

- From the result it was found to be very effective in compression strength and flexural strength when compared with nominal concrete.
- The results shows for the above replacement, there is an increase in compressive strength achieved by 30 % of nominal mix (M25).
- From the experimental studies, it is suggested that replacement of cement and fine aggregate by ceramic powder for 30% and Copper slag for30% is effective and can be used in the construction activities.

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