An Experimental Investigation on behaviour And Performance of Concrete with Partial Replacement Of Natural Fine Aggregate with Robo Sand And Carbon Black

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Abstract- *The sustainability, strength durability of any of the constituent material of concrete plays an important role in studying and determining the effects on the properties of concrete. Pores in concrete seem tobe an immense problem ever since concrete was discovered. Pores attract water that leads to the ill effects such as acid intrusion freezing & thawing decrease in resistance to chloride ion reduced compressive strength etc. Less permeability of concrete plays an important role in gaining strength and reducing corrosion of reinforcement in concrete. This paper reviews in studying the properties of concrete using quarry dust(Robo sand) and carbon black as a partial replacement of natural fine aggregate by using different percentage of both the materials. It was also found that at the percentage replacement of cement by carbon black (CB) (5%) and Robo sand (RS) by natural sand (50%), the concrete becomes denser as both carbon black and stone dust act as micro fillers in the concrete due to their sizes with respect to cement and natural sand*

I. INTRODUCTION

Concrete is widely used construction materials in the world, mainly due to its favorable features such as durability, satisfactory compressive strength, cost effectiveness and availability. The concrete being the main construction materials, it is being used in various applications and the strength of concrete below 60 Mpa.

Conventionally concrete is mixture of cement, sand and aggregate Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete.

The construction industry is the base for all activities of development. Concrete and steel are the two most commonly used structural materials for construction. Concrete is one of the manmade materials, which finds wider application in the construction industry. The ingredients of concrete are cement, sand, coarse aggregate.

There are many formulations which provide varied properties. The aggregate is generally coarse gravel or crushed rocks such as limestone or granite, along with a fine aggregate such as sand. The cement commonly Portland cement Portland cement and other cementitious materials such as fly ash and slag cement and slag cement serve as a binder for the aggregate. Concrete is a friend of the environment in all stages of its life span, from raw material production to demolition, making it a natural choice for sustainable home construction.

Concrete mix design are prepared using IS method and total 60 specimens were casted with replacement of chipped rubber in concrete. The specimens were prepared with percentage replacements of the fine aggregate by 5, 10, 15 and 20 percentages of Robo Sand & 2, 4 percentage by means of Carbon Black. For comparative analysis, M20 grade concrete mix is prepared with no replacement of alternatives.

II. MATERIALS USED

General:

Cement concrete is a mixture of cement, sand, and water held together due to binding property of the cement. Cement is the important building material used in all modern constructions. Cement concrete has a high compressive strength. This experimental study involves addition of mineral admixtures (Combination of silica fume (SF). Various materials used in this experimental study and their properties are discussed here.

Materials:

- Cement

- Fine aggregate
- Coarse aggregate
- Carbon black
- Robo sand

CEMENT:

Cement is a popular binding material and a very important civil engineering material. Cement is a crystalline compound of calcium silicates and other calcium compounds having hydraulic properties. Lime and clay are used as a cementing material over the centuries. Clay provides silica, alumina and iron oxide while calcined lime basically provides calcium oxides.

Cement

FINE AGGREGATE:

The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The fine aggregate also assists the cement paste to hold the coarse aggregate particles in suspension. This action promotes plasticity in the mixture and prevents the possible segregation of paste and coarse aggregate, particularly when it is necessary to transport the concrete some distance from the mixing plant to point placement. The locally available clean, well graded and manufactured sand was collected for experimental work. Fine aggregate properties were evaluated as per the IS 383-1970 methods.

COARSE AGGREGATE:

The coarse aggregate is the strongest and least porous component of concrete. It is chemically stable materials. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of movement of moisture. Aggregates passing through 20 mm sieve and retained on 10 mm sieve are used as coarse aggregate. The crushed stone aggregate is collected from local quarry and their properties are shown in table. The coarse aggregate used in the experimentation were tested as per IS 383-1970 and 2386-1963(I, II and III) specification.

COARSE AGGREGATE

CARBON BLACK:

Carbon black is effectively pure carbon which is formed by incomplete burning/thermolysis the compounds made up of hydrogen and carbon. The appearance of carbon black is black, fine powder. It is an unwanted material obtained from the rubber manufacturing industries and hence it is difficult to dispose. Normally these wastes from rubber manufacturing industries are decomposed in the soil thereby causing soil contamination and pollution in water. By utilizing carbon black as filler, this problem can be reduced to a high degree.

CARBON BLACK

ROBO SAND:

Robo Sand is obtained from crushing stones in a quarry. The sand used in concrete must have a proper gradation of 150 microns to 4.75 mm. The fineness modulus of robo sand is 2.52. The uniformity coefficient is less than 6 and its specific gravity if 2.66.

ROBO SAND

CASTING OF TEST SPECIMENS:

Concrete is mixed manually with the proper mix proportion. Oil is applied on all the sides of the mould to aid in easier demolding. Care is taken to see that the concrete is properly placed beneath and also on the sides of the mould. The concrete is compacted fully with the help of tamping rod and trowel. The concrete is mixed before the initial setting starts. In this experimental study, totally 24 cubes, 24 prism, 24 cylinders were casted.

CURING:

The concrete surfaces are kept wet for a 7 and 28 days after placing concrete, so as to promote the hardening of concrete it consist of a control of temperature and of the moisture movement into the concrete the term curing of concrete is used to indicate all such procedures and processes.

TESTING OF SPECIMEN:

Testing of concrete plays an important role in controlling and confirming the quality of cement concrete works. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control of concrete which helps to achieve higher efficiency of material used and greater assurance of the performance of concrete with regard to strength.

One of the purposes of testing harden concrete is to confirm that the concrete is used at site has developed the require strength. As the hardening of concrete takes time, one will not come to know, the actual strength of the concrete sometimes. The average strength of concrete cubes is to be tested after a curing period of 7 days and 28 days as per IS: 516-1959.

COMPRESSIVE STRENGTH TEST

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength.

The compression test is carried out for cube specimens. The cube specimen is 150x150x150 mm if the largest nominal size of aggregate does not exceed 20 mm. The compressive strength is calculated by using the equation,

$F=P/A$ in N/mm^2

Where,
F is force in N/mm^2
P is load in N
A is area in mm^2

SPLIT TENSILE STRENGTH TEST:

The tensile strength is one of the basic and important properties of the concrete. The concrete in not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. The test consists of applying a compressive strength line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive plates. The tensile strength of is calculated using the equation,

$F=2P/LD$ in N/mm^2

Where,
F is force in N/mm^2
L is length of the specimen in mm
D is cross section of dimension or diameter in mm.

FLEXURAL STRENGTH TEST:

The flexural strength test is conducted as per the IS: 519-1959 codal provisions. The flexural strength is also known as modulus of rupture or fracture strength. It is a mechanical parameter for brittle material and is defined as a materials ability to resist deformation under load. The flexural strength represents the highest stress experienced within the material at its moment of rupture. When concrete is subjected to bending, tensile and bending compressive stresses and shear stresses are developed. It is a measure of unreinforced concrete beam or slab to resist failure in bending. Flexure strength was measured by loading 95x90x500 mm concrete beams with a span at least three times the depth. The test

specimen was cured for 7 and 28 days and tested for maximum load.

Flexural strength, fcr= PL/ BD^2 in mm^2

Where,
P= Ultimate load applied to the specimen in N
L= Length of specimen in mm
B= Breadth of the specimen in mm
D= Depth of the specimen in mm

III. RESULT AND DISCUSSION

WORKABILITY:

Since the size of robo sand is very less than that of natural sand, hence during the mixing, the workability gets reduced. On the other hand, carbon black is inert i.e. it has very less positive and negative charges and carbon black has less absorption rate with water creating a sort of repulsive force, which has a great advantage in workability. Hence blending of the two materials, on one hand the workability gets reduced, but on the other hand, carbon black nullifies the reduced workability. This can lessen the water/cement ratio and has a role to act as a super plasticizer.

DURABILITY PROPERTIES:

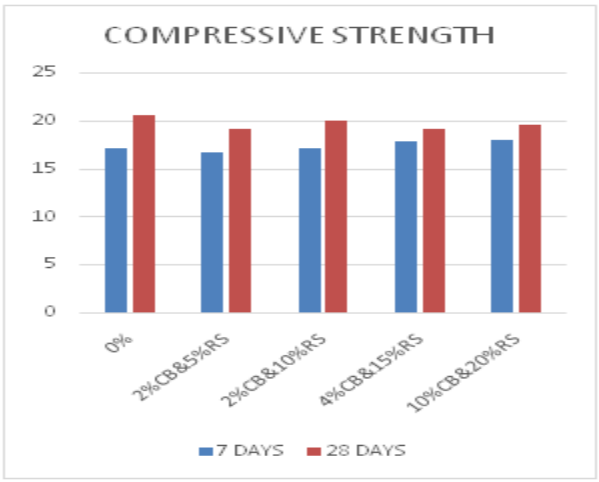
As mentioned above, there is pore refinement of concrete when carbon black and robo sand is added to concrete due to which permeability is reduced. As studied by us on decreasing the permeability, the water entering the concrete will be less than that of the water entering in conventional concrete. Hence there will be less corrosion of reinforcement when CB and RS are added to the concrete. Hence both the materials play an important role in sustaining the concrete for a long time.

COMPARATIVE COMPRESSIVE STRENGTH

PERCENTAGE	0%	2%CB		4%CB	
		5 %RS	10 %RS	15 %RS	20 %RS
7 DAYS	17.06	16.61	17.04	17.86	17.93
28 DAYS	20.51	19.14	19.99	19.15	19.54

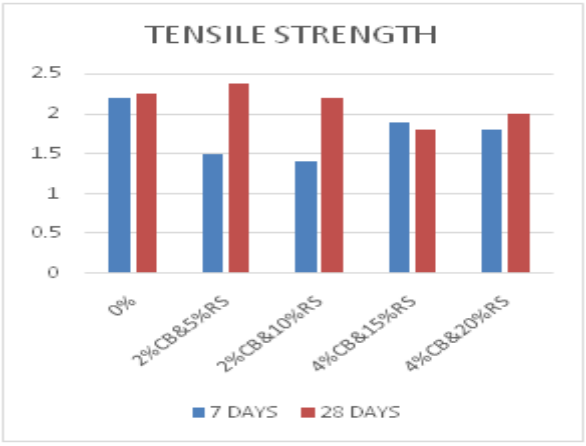
COMPARATIVE TENSILE STRENGTH

PERCENTAGE	0%	2%CB		4%CB	
		5 %RS	10 %RS	15 %RS	20 %RS
7 DAYS	2.20	1.5	1.41	1.88	1.79
28 DAYS	2.25	2.38	2.19	1.79	1.99



COMPARATIVE FLEXURAL STRENGTH

PERCENTAGE	0%	2%CB		4%CB	
		5 %RS	10 %RS	15 %RS	20 %RS
7 DAYS	2.20	1.5	1.41	1.88	1.79
28 DAYS	2.25	2.38	2.19	1.79	1.99



IV. CONCLUSION

The review of literature of concrete using robo sand and carbon black and the preliminary tests have shown that using of carbon black and robo sand in concrete plays a significant role in increasing the strength and decreasing/ minimizing the corrosion of steel reinforcement which in turn increase the age of the concrete.

It can be concluded that the strength of concrete is maintained and penetration of water in the concrete (permeability) decreases as the robo sand/quarry dust and carbon black content percentage rises. This is because when the carbon black at 2%,4% replacement is added and natural river sand is replaced by quarry sand by 5% to 20%, the pores in the concrete gets blocked thereby increases the compressive -strength and in turn decreases the permeability.

Thus, in turn increases the durability and sustainability properties of the concrete. Moreover, replacing carbon black and robo sand in concrete will not only provide strength to concrete but also it will help in the waste management, thereby decreasing the environmental pollutions and ground water contaminations. Hence both the wastes will be managed effectively/properly.

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