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EFFECT ON PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF ADDITIVES WITH CEMENT

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ABSTRACT

The current tendency in the world is to find new materials at lower cost which can guarantee better performances during their incorporations in the concrete. This study consist the development and properties of concrete by partial replacement of additives, Carbon Black Powder & Calcium Sulphate with Cement.

An attempt was made using carbon black powder, a waste from rubber industry as filler and which imparts the enhanced properties of concrete.WhereasCalcium Sulphate is in the form of hydrate and used as desiccant; Both of these additives are partially replaced by cement with different percentage. Concrete cubes and cylinders are cast depending on percentage ratio and it's effect is studied at different ages by performing tests on concrete specimens. A comparison is made with test results to conventional concrete only to arrive at valid conclusion.

KEYWORDS: Concrete, Carbon Black Powder, Calcium Sulphate(CaSO4), Properties Of Concrete.

INTRODUCTION

Concrete is a mixture of naturally, cheaply and easily available ingredients as cements and, aggregate and water. Cement is occupied second place as most used material in the world after water. The rapid production of cement creates big problems to environment. First environment problem is emission of CO_2during the production process of the cement. The CO_2 emissionis very harmful which creates big changes in environment. According to the estimation, 1tone of carbondioxide is released to the atmospherewhen1toneofordinaryPortland is manufactured. As there is no alternative building material which totally replace the cement. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. Substantial energy and cost savings can result when industrial by products are used as a partial replacement of cement. Flyash, Ground Granulated Blast furnace Slag, Ricehusk ash, High Reactive Metakaolin, silica fume are some of the pozzol anic materials (additives) which can be used in concrete as partial replacement of cement. In this project the PET as a partial replacement of fine aggregate and Carbon Black as a partial replacement of Cement.

After Studyingdifferent journals it suggest that additives or mineral admixtures may enhance the concrete properties. Further studies establish the behavior of carbon black powder and calcium sulphate particularly effecting the parameters, such as strength, setting time, soundness, consistency, shrinkage, bleeding, heat of hydration etc. with respect to properties of materials used in it like aggregate, sand, cement, water, and other admixtures.

A study is made to minimize the pores present using carbon black powder, a waste from rubber industry as filler and calcium sulphate powder. Due to their extreme small size they can fill the pores thereby it is expected to achieve the benefits by Increasing in density of concrete thereby increase in strength and resistance to atmospheric attack. Also Decrease in permeability of concrete.

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To suggest the optimum percentage of addition above additives in concrete number of cubes with different percentage were cast. The strength properties were again studied and its results are compared to conventional concrete.

OBJECTIVES

1. To study the behavior of carbon black powder and calcium sulphate powder in concrete by partially replacing it with cement.
2. To investigate effect of carbon black and calcium sulphate powder on wet properties of concrete.
3. To investigate effect of carbon powder and calcium sulphate both by partial replacement on harden concrete properties.
4. To study the effect of fly ash and other admixtures based on conventional concrete.
5. To evaluate the optimum mix proportion of cement and other powder base admixtures.

MATERIALS AND METHODS

Aggregates

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete.For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories--fine and coarse.

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. Locally available Crushed Sand to be used as fine aggregates in the concrete mixes having specific gravity of 2.6 to 2.8.

Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Locally available 12.5 mm and 20mm crushed aggregates to be used as coarse aggregate.
Both fine and coarse aggregate are collected locally.

Cement

To ensure a level of consistency between cement-producing plants, certain chemical and physical limits are placed on cements. These chemical limits are defined by a variety of standards and specifications.

Cement of grade 43 ordinary Portland cement been used by production of J.K. Cement PVT. LTD. Company. All physical and chemical properties of Cement must be as Indian standards.

Fly ash

It is the residual form obtained from combustion of powdered coal and transported by the flue gases and collected by electrostatic precipitation. It has a surface area 300 to 700 m^2/kg. Its particles are finer than cement particles. It is light grey to dark grey in colour. Its chemical composition is,

- 30 to 60% of silicon
- 15 to 30% of Aluminum oxide (Al_2O_3)
- 30% of carbon
- 1to 7% of calcium oxide and
- Small amount of MgO& SO

It is used in mass concreting in dams, retaining walls etc.

A by-product of coal-fired electric generating plants, it is used to partially replace Portland cement (by up to 60% by mass). The properties of fly ash depend on the type of coal burnt. In general, siliceous fly ash is pozzolanic, while calcareous fly ash has latent hydraulic properties.

Working Properties of Fly Ash can be found out by Blaine's apparatus test and by wet process tests. From which determination of it's compressive strength and workability can be done.

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Carbon black

Carbon black (subtypes are acetylene black, channel black, furnace black, lamp black and thermal black) is a material produced by the incomplete combustion of heavy petroleum products such as FCC tar, coal tar, ethylene-cracking tar, and a small amount fromvegetable oil. In plastics, paints, and inks carbon black is used as a color pigment.Carbon black is virtually pure elemental carbon intheform of colloidal particles that are produced byincompletecombustion or thermal decomposition of gaseous orliquidhydrocarbons under controlledconditions. Itsphysicalappearance is that of a black, finely divided pelletorpowder. It is a waste fromrubber industry, findsdifficultyin disposal. Normally these rubber wastes are dumpedintosoil creatingsoil pollution and contamination ofwatertable. By using carbon black as filler in concrete wecanreducethis problem to a great extent. Thereby reusingthewaste usefully and making it eco-friendly to environment.

The specific gravity of carbon black was determinedbydensity bottle method and it was found to be 1.33. ThepHvalue was found to be 6. This indicates that carbon blackisalmost an inert material.

Figure:

Carbon Black

Calcium sulphate (caso4)

Gypsum is an indispensable component of ordinary Portland cement. The main function of gypsum is to regulate the setting time of cement. Gypsum has a great influence on water consumption of standard consistence and strength simultaneously. In many areas three cementitious systems are prepared by three main mixed materials: limestone, fly ash and slag. The effect of gypsum content and the relation between gypsum quantity and the fluidity of cement with Marsh cone method are studied. Experimental results show that when the gypsum was added in the three kinds of cementitious system, water consumption of standard consistence decreased obviously, and with the quantity of gypsum increased, water demand for normal consistency reduced first, up to a certain extent tended smoothly. With the increase of gypsum quantity, initial and final setting time had different degrees of extension. While a saturation quantity is achieved, setting time will keep steady. The flexural strength and the compressive strength increased gradually and tended to be stable with the increase of gypsum quantity. When gypsum content exceeded a certain range, compressive and flexural strength decreased gradually. But gypsum content and the mobility of systems had little relativity with Marsh cone method.

One another furious type of gypsum is anhydrite gypsum. Anhydrite is an evaporite mineral that occurs in extensive layered deposits in sedimentary basins where large volumes of sea water have been evaporated. It is typically interbedded with halite, gypsum, and limestone in accumulations that can be up to hundreds of feet thick. On a much smaller scale, anhydrite can form in shoreline or tidal flat sediments from the evaporation of sea water.

Anhydrite also occurs as a vein-filling mineral in hydrothermal deposits. It is deposited from solution, often along with calcite and halite, as gangue in sulfide mineral deposits. Anhydrite is also found in the cap rock of salt domes and in cavities of trap rock.

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Anhydrite is an anhydrous calcium sulfate with a composition of $CaSO_4$. It is closely related to gypsum, which has a chemical composition of $CaSO_4 \cdot 2H_2O$. The worldwide abundance of gypsum greatly exceeds the abundance of anhydrite.

One ton of anhydrite has more calcium than one ton of gypsum - because gypsum is about 21% water by weight. This yields more calcium per ton in a soil application. Small amounts of anhydrite are used as drying agents in plaster, paint, and varnish. It is also used along with gypsum to produce plaster, joint compound, wallboard, and other products for the construction industry. Anhydrite has also been used as a source of sulfur in the production of sulfuric acid.

Figure:

Calcium Sulphate

Water
Drinkable and quality water is used having ph upto 7.

PREPARATION OF TEST SPECIMENS

To suggest the optimum percentage of addition above additives in concrete number of cubes with different percentage were cast. The strength properties were again studied and its results are compared to conventional concrete.

Fixed proportion of conventional concrete mix of M25 is used. And concrete cubes are casted for different percentage (0%, 1%, 3%, 5%, 7%, 9% & 12%) of carbon black powder and calcium sulphate with it's partial replacement of cement.

Tests are carried out on three experimental stages as, Basic tests for individual properties of material, then wet properties of concrete, harden properties of concrete. Concrete moulds are formed for Nominal Mix, Carbon black powder mix concrete, Calcium Sulphate mix concrete, and Both Carbon Black & Calcium Sulphate mixing concrete. Tests are carried out after 7^{th} and 28^{th} days of curing. In this study, hand mixing was done. Since both additives was finding difficulty in blending withtheingredients of concrete, to obtain a cohesive mix different mixing procedure was adopted. The coarseaggregates,fineaggregatesandwaterweretakenbyweightbasisandmixed manually on a water tight platform. Waterwasadded gradually until all the materials were mixed togetuniform mix. After 10 minutes the cement and theremnantof water were added. After 2 minutes of mixing,carbonblack was introduced and mixed for 3 additionalminutes.

TESTS ON THE SPECIMENS

Tests To Be Carried Out On Wet Concrete:

Slump Cone Test:
Generally **concrete slump value** is used to find the workability, which indicates water-cement ratio, but there are various factors including properties of materials, mixing methods, dosage, admixtures etc. also affect the concrete slump value. Also to find out the factors Air content of concrete, the amount of free water in the concrete.

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Compacting Factor Test:

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The apparatus used is Compacting factor apparatus. The test is sufficiently sensitive to enable difference in work ability arising from the initial process in the hydration of cement to be measured. Each test, there for should be carried out at a constant time interval after the mixing is completed, if strictly comparable results are to be obtained. Convenient time for releasing the concrete from the upper hopper has been found to be two minutes after the completion of mixing.

Kelly Ball Test

The simple and inexpensive test can be quickly performed on in-place concrete and the results can be correlated to slump. The test apparatus consists of a 6 inch diameter, 30 pound ball attached to a stem, as shown in Figure 6. The stem, which is graduated in ¼ inch increments, slides through a frame that rests on the fresh concrete. To perform the test, the concrete to be tested is stuck off level. The ball is released and the depth of penetration is measured to the nearest ¼ inch. At least three measurements must be made for each sample.

Advantages

• The test is faster than the slump test and can be preformed on in-place concrete to obtain a direct result quickly.

• It has been claimed that the Kelly ball test provides more accurate results than the slump test.

Vee-Bee Consistometer Test

To determine the workability of freshly mixed concrete by using of Vee – Bee consistometer apparatus. The workability of fresh concrete is a composite property, which includes the diverse requirements of stability, mobility, compact-ability, place-ability and finish-ability. The test measures the relative effort required to change a mass of concrete from one definite shape to another (i.e., from conical to cylindrical) by means of vibration. The amount of effort (called remoulding effort) is taken as the time in seconds, required to complete the change. The results of this test are of value when studying the mobility of the masses of concrete made with varying amounts of water, cement and with various types of grading of aggregate. The time required for complete remoulding in seconds is considered as a measure of workability and is expressed as the number of Vee-Bee seconds. The method is suitable for dry concrete. For concrete of slump in excess of 50mm, the remoulding is so quick that the time cannot measured.

Tests To Be Carried Out On Hardened Concrete

Compressive Strength Of Concrete

The test is conducted at surface dry condition. The specimens are tested at the age of 7 and 28 days of curing under the Compression Testing Machine. The tests were carried out on a set of triplicate specimens and the average compressive Strength values were taken.

Flexural Strength Test

Flexural strength test was conducted on concrete prism to determinet he flexural nature of admixture concrete cube. The load was applied continuously without shock at a constant rate. The breaking load(P) was noted.

$$\text{Theflexuralstrengthf}_b = PL/\ bd^2 N/mm^2$$

Split Tensile Strength Test:

Splitting tensile strength test was conducted on concrete cylinders to determine the tensile nature of ad mixture concrete cube. The cylinder specimen was place do n compression testing machine. The load was applied continuously without shock at a constant rate. The breaking load(P) was noted.

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$$\text{Split Tensile Strength}(N/mm^2) = \frac{2*\text{Breaking load}}{\prod*\text{Dia of cylinder}*L}$$

Water Absorption Test

To study the permeability of concrete andto measure the strength or quality of the material.The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Water absorption test was conducted on concrete cubes to study the permeability of carbon black and CaSO4 concrete. Cubes are immersed in water at room temperature for 24 hours. Then the cubes are removed from it and allowed to drain for a minute and weighed. After weighing, all cubes are dried in a ventilated oven at 100 to 115 c and weighed. The weight loss are measured.

Polarization Test For Corrosion Rate Measurement

Cyclic potentiodynamic polarization technique is a relatively non-destructive measurement that can provide information about the corrosion rate, corrosion potential, susceptibility to pitting corrosion of the metal and concentration limitation of the electrolyte in the system. The technique is built on the idea that predictions of the behavior of a metal in an environment can be made by forcing the material from its steady state condition and monitoring how it responds to the force as the force is removed at a constant rate and the system is reversed to its steady state condition. Applied potential is the force and is raised at a continuous, often slow, rate by using potentiostat. This rate is called polarization scan rate and is an experimental parameter.

It is very important to choose the most appropriate scan rate, specifically in the complicated system such as reinforced concrete; otherwise the result does not reflect the corrosion behavior and the result could be an incorrect polarization scan and an incorrect prediction from it. In this paper, the effect of different scan rates on the apparent corrosion behavior is shown and a method to choose the appropriate rate is discussed.

RESULTS AND DISCUSSION

Compressive strength test, on specimens, which are casted as per different ratios of additives in mix concrete will give standard strength of each specimens and also will give the room for further detailed study. As per compressive test results at which it gives maximum value i.e. peak value of respective ratio can be carried out for further testing studies.

Based on it durability test can be performed on specimen of calcium sulphate as after 28 days due to addition of sulphatesspalling and damage to concrete may took place. Same as for carbon black concrete cube specimen where corrosion may took place due to dosage of carbon and polarization test is carried out to check the effect on steel.

In this manner tests are carried out on specimens with both individual additives also a combination of both additives is opted out so that it's effect on properties of concrete can be checked.

In this research project aim must get fulfill by finding more durable and workable replacement to cement and carrying more and more waste material and additives by making concrete more eco friendly and economical. And also not compromising with properties of concrete and it's effect on structure and other elements.

CONCLUSION

After mixing carbon black powder and calcium sulphateas an additive in concrete, partially replacing cement contents, concrete properties like workability, setting time, bleeding, reactivity, hardness, shrinkage, etc. and other physical and chemical properties gets integrated.If they added in accurate and right percentage ratio their bonding matrix acts more effectively. Also chances of carbon and sulphate attack can be manipulated.
Compressive, tensile and flexure are most important parameters to get upto the maximum results. As other tests and mix design of it depends upon these parameters therefore they are mendatory.

With addition of waste material and other admixtures in cement concrete enhances the strength also makes concrete more economical and eco-friendly.

Also the large amount of carbon production can be controlled.

To Investigate the performance of concrete with different percentage of carbon black powder and calcium sulphate.

Studying different additives, admixtures as a replacement of cement and its effect on performance of concrete.
In further study, combination of different sulphates such as magnesium, calcium, sodium can be studied.

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REFERENCES

[1] CarbonBlackasanAdditiveinConventionalConcrete.Dr.G.Chitra,P.VetriSelvi,Dr.D.Vijayalakshmi(2014). InternationalJournal ofEmergingTechnologyandAdvancedEngineering.
[2] TheEffectofAddedCarbonBlacktoConcreteMixonCorrosionofSteelinConcrete.SamiMasadeh,Journal of MineralsandMaterialsCharacterizationandEngineering,2015.
[3] UseofRecycledPlasticWasteasPartialReplacemntforFineaggregateinConcrete.B.Harini,K.V.Ramana. InternationalJournal ofInnovativeResearchinScienceEngineering andTechnology(2015).
[4] EffectofnonbiodegradablewasteinConcreteSlabs.Venumalagavelli.InternationalJournalofCivil& Structur al Engineering(2010).
[5] PreliminaryanalysisofConcretereinforcedwithwastebottlesPETfibres.Dora Foti.ConstructionandBuildingMaterials(2011).
[6] Effect of W/C Ratio on Workability and Mechanical Properties of High Strength Self Compacting Concrete (M70 Grade)" by Mallikarjuna Reddy V, SeshagiriRao M V, International Journal of Engineering Research and Development may 2013.
[7] "Effect on compressive and flexural strength of high-performance concrete incorporating alccofine and fly ash" by P. J. PATEL & H. S. PATEL, International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD). Feb 2013.
[8] "High strength concrete containing natural pozzolan and silica fume" by M.J. Shannag, Elsevier Science Ltd, Cement & Concrete Composites 22 (2000).
[9] ACI code 211.4R-08: "Guide or selecting proportions for HSC using Portland cement and other cementitious material."
[10] IS 10262: 2009 "Indian standard concrete mix proportioning guidelines" (First Revision).
[11] IS 383, "Specifications for Coarse and Fine Aggregates from Natural Source of Concrete," Bureau of Indian standard New Delhi, 1982.
[12] IS: 516-1959, Edition 1.2 (1991-07), "Indian Standard for Methods of test for strength of concrete
[13] "Short-Term Mechanical Properties of High-Strength Concrete" by Andrew Logan, Wonchang Choi, Amir Mirmiran, Sami Rizkalla, and Paul Zia, ACI Materials Journal, Title no. 106-M46.
[14] "Mechanical Properties of High Strength Concrete Using Fly Ash" by Ali Elheber Ahmed Elshekh, NasirShafiq etc. IEEE Journal 2013.
[15] "Effects of various tests on mechanical properties of high strength concrete" by 1Alireza Mokhtarzadeh And Catherine E. French (2002)
[16] "Considerations in producing high strength concrete" by Mohammad AbdurRashida and Mohammad AbulMansurb, Journal of Civil Engineering (IEB), 37(1) (2009) 53-63.