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. Whereas Calcium 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 CO2 during the production process of the cement. The CO2 emission is very harmful which creates big changes in environment. According to the estimation, 1tone of carbondioxide is released to the atmospherewhen 1tone of ordinary Portland 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 Studying different 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.
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 m²/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 (Al₂O₃)
- 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.
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 from vegetable oil. In plastics, paints, and inks carbon black is used as a color pigment. Carbon black is virtually pure elemental carbon in the form of colloidal particles that are produced by incomplete combustion or thermal decomposition of gaseous or liquid hydrocarbons under controlled conditions. Its physical appearance is that of a black, finely divided pellet or powder. It is a waste from rubber industry, finds difficulty in disposal. Normally these rubber wastes are dumped into soil creating soil pollution and contamination of water table. By using carbon black as filler in concrete we can reduce this problem to a great extent. Thereby reusing the waste usefully and making it eco-friendly to environment.

The specific gravity of carbon black was determined by density bottle method and it was found to be 1.33. The pH value was found to be 6. This indicates that carbon black is almost an inert material.

Figure:

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.
Anhydrite is an anhydrous calcium sulfate with a composition of CaSO₄. It is closely related to gypsum, which has a chemical composition of CaSO₄·2H₂O. 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](image)

**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 7th and 28th days of curing. In this study, hand mixing was done. Since both additives was finding difficulty in blending with the ingredients of concrete, to obtain a cohesive mix different mixing procedure was adopted. The coarse aggregates, fine aggregates and water were taken by weight basis and mixed manually on a water tight platform. Water was added gradually until all the materials were mixed to get uniform mix. After 10 minutes the cement and theremnant of water were added. After 2 minutes of mixing, carbon black was introduced and mixed for 3 additional minutes.

**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.
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 performed 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 be 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.

\[ \text{The flexural strength} = \frac{PL}{bd^2} \text{N/mm}^2 \]

Split Tensile Strength Test:
Splitting tensile strength test was conducted on concrete cylinders to determine the tensile nature of admixture 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.
Water Absorption Test
To study the permeability of concrete and to 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 sulphate as 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 up to the maximum results. As other tests and mix design of it depends upon these parameters therefore they are mandatory.
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 sulphate.

Also the large amount of carbon production can be controlled.

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