EFFECTS OF SODIUM SULPHATE AND MAGNESIUM SULPHATE SOLUTION ON STRENGTH AND DURABILITY OF CARBON FIBRE REINFORCED CONCRETE

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Abstract- Concrete without reinforcement is brittle which is intensified in high strength concrete. Fibers have been utilized to improve the tensile and bending performance of concrete. Fibers primarily control the propagation of cracks and limit the crack width.Carbon fiber reinforced concretes are reliable structural materials with superior performance characteristics compared to conventional concrete. The addition of carbon fiber in concrete has been found to improve several properties, primarily cracking resistance, ductility and fatigue life. In the present study durability properties of high strength concrete (M30) reinforced with different volume fractions of carbon fiber under sulphate attack using Na2SO4 & MgSO4 solutions were investigated. The volume fraction of fiber taken are 0.0%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5% and 0.6%. Fiber volume fraction was the most prominent factor.

Keywords- Carbon fiber, Carbon Fibre Reinforced Concrete, durability properties and volume fraction

I. Introduction

Concrete is considered a brittle material, primarily because of its low tensile strain capacity and poor fracture toughness. Reinforcement of concrete with short randomly distributed fibers can address some of the concerns related to concrete brittleness and poor resistance to crack growth. Concrete can be modified to perform in a more ductile form by the addition of Carbon fibers in the concrete matrix. Carbon fiber is a long thin strand of Carbon atoms that are bonded together in a honeycomb crystal lattice called Graphene. Some of the Graphene layers are folded around each other in random orientations but most are aligned parallel to the long axis of the strand. Carbon fiber cement-matrix composites are structural materials that are gaining in importance quite rapidly due to the decrease in carbon fiber cost and the increasing demand of superior structural and functional properties. These composites contain chopped carbon fibers, typically 6 mm in length, as the short chopped carbon fibers can be used as an reinforcement in concrete (whereas continuous fibers cannot be simply added to the concrete mix) and short chopped fibers are less expensive than continuous fibers .The effects of carbon fiber addition on the properties of concrete increases with fiber volume fraction, unless the fiber volume fraction is so high that the air void content becomes excessively high. Moreover, the cost increases with fiber content. Therefore, a rather low volume fraction of fibers is desirable. A fiber content as low as 0.5% volume is effective. It is well known that one of the problems of a cement-based material is the intrinsically brittle type of failure owing to low tensile strength and poor fracture toughness that impose constraints in structural design and long-term durability of structures. In order to satisfy the performance of cement-based matrices, in addition of fibers is getting growing interest to increase the toughness, impact resistance, fatigue endurance, energy absorption capacity as well as tensile properties of the basic matrix. As a result of the above advantages, fiber reinforced cement-based composites are steadily used in hydraulic structures, tunnel linings, highway and airfield pavements and tensile skin in concrete beams and slabs.

In the early stage of fiber development, steel and glass fibers with geometry straight and smooth were used, as these fibers improve in ductility, flexural strength and fracture toughness of concrete matrix. Various fibers are available in market. The primary factors that controlled for this composition were fiber volume fraction and length/diameter ratio. However, the problems faced were difficulty in mixing and workability. Fibers that are long and at higher volume fractions were found to ball up during the mixing process. The process called ‘balling’ occurs, causes the concrete to become stiff and a reduction in workability with increased volume dosage of fibers. This has a tendency to influence the quality of concrete and strength. The introduction of fibers was brought in as a solution to develop concrete in view of enhancing its flexural and tensile strength, which are a new form of binder that could combine Portland cement in the bonding with cement matrices. Fibers are most generally discontinuous, randomly distributed throughout the cements matrices. The term of ‘Fiber reinforced concrete’ (FRC) is made up with cement, various sizes of aggregates, which incorporate with discrete, discontinuous fibers. However, they are relatively expensive when compared to similar fibers, such as glass fibers or plastic fibers.

II.METHODOLOGY

In this chapter tests related to the materials, coarse aggregates, fine aggregates, cement, admixtures are stated. Mix design for M30 concrete and test on fresh concrete as well as hardened concrete with and without carbon fiber is also given in this chapter. Cement consists of four major compounds Tricalcium Silicate (C3S), Dicalcium Silicate (C2S), Tricalcium Aluminates (C3A) & Tetra calcium Aluminoferrite (C4AF). Tricalcium Silicate (C3S) and Dicalcium Silicate (C2S) are the most important compound responsible for strength. Together they constitute 70 to 80 percent of cement. The average C3S content in modern cement is about 45 percent and that of C2S is about 25 percent. During the course of reaction of C3S and C2S with water, calcium silicate hydrate (C-SH) and calcium hydroxide (Ca (OH) 2) are formed. Calcium silicate hydrates are the most important products and determines the good properties of concrete. C3S readily reacts with water and produces more heat of hydration. It is responsible for early strength of concrete.

III. LITERATURE SURVEY

.2.1 Ahmet B Kizilkanat *et al* (2016): experienced that, concrete without reinforcement is brittle which is intensified in high strength concrete. Fibers have been utilized to improve the tensile and bending performance of concrete. Fibers primarily control the propagation of cracks and limit the crack width. Carbon fiber reinforced concrete are reliable structural material with superior performance characteristics compared to conventional concrete. The addition of carbon fiber in concrete has been found to improve several properties, primarily cracking resistance, ductility and fatigue life. This paper reports a study on the mechanical and fracture properties of high strength concrete reinforced with different volume fraction of carbon fiber. Four different volume fractions between the ranges of 0.25% to 1.00% were chosen. Carbon fiber improves compressive strength, load bearing capacity, fracture energy and toughness of concrete. Fiber volume fraction was more prominent factor in this regard. Fracture parameters shows better performance beyond 0.50% fiber inclusion.

2.2.2 D.D.L. Chung *et al* (1999): had a review of cement-matrix composites containing short carbon fibers. These composites exhibit attractive tensile and flexural properties, low drying shrinkage, high specific heat, low thermal conductivity, high electrical conductivity, high corrosion resistance and weak thermoelectric behavior. Moreover, they facilitate the cathodic protection of steel reinforcement in concrete, and have the ability to sense their own strain, damage and temperature. Fiber surface treatment can improve numerous properties of the composites. Conventional carbon fibers of diameter 15 mm are more effective than 0.1 mm diameter carbon filaments as a reinforcement, but are much less effective for radio wave reflection (EMI shielding). Carbon fiber composites are superior to steel fiber composites for strain sensing, but are inferior to steel fiber composites in the thermoelectric behavior. IV. OBJECTIVES

A.To find out shear strength of concrete.

B.To determine Modulus of Elasticity (MOE) and /or Poison's ratio of concrete.

V. DISCUSSION

With the discussion and results obtained from experimental test, it is clear to know the effect of carbon fiber.

1. Workability test (Slump cone test)

The experimental results showed that the slump of the fiber reinforced concrete has a decreasing trend when the fiber volume dosage rate increases. For the control mix, value is about 92 mm with no fiber added to the concrete. Once the fiber was added into the concrete an average slump drops from 3-7 mm was observed for every 0.1% increase in fiber volume dosage.

2. Mechanical Properties

It is observed that the rate of increase is higher when the volume dosage rate up to 0.5%. maximum compressive strength of 30.44 MPa (7days) & 42.44 (28days) is observed at fiber volume of 0.5% & 0.4% respectively which also indicates increase of 5.492 MPa (7days) & 6.89 MPa (28days) when compared with control mix.

3. Durability

In the case of sulphate attack on concrete, concrete with no fiber dosage and concrete with fiber shows a response at the end of curing period. At all stages of immersion in Na_2SO_4 & $MgSO_4$ concrete have had faced attack of Na_2SO_4 & $MgSO_4$. When the concrete has immersion in sulphate Na_2SO_4 & $MgSO_4$, it showed depreciation in concrete starts from 3.09% to 3.32% at the age of 7 days.

At the age of 28 days, concrete with carbon fiber had a showed falling response in case of sulphate attack of Na_2SO_4 & $MgSO_4$.

VI. EXPERIMENT AND WORK

This experimental work concerned to investigates the mechanical properties of M30 hardened concrete after addition of chopped carbon fiber. Cubes 150x150x150 mm were casted to check out the compressive strength & durability of concrete under the sulphate attack (Na_2SO_4 & $MgSO_4$ solutions). While testing for the various mechanical properties, chopped carbon fiber were added in the % volume of concrete from 0% to 0.6% by the volume of concrete.

VII. ADVANTAGES AND DISADVANTAGES

A. Advantages

- They possess high strength
- Low specific weight
- Thickness (1 to 1.4 mm)
- Economical solution in wide applications

B. Disadvantages

- Sometime needs mechanical cooling while in application in warmer place onl

VIII. CONCLUSION

From the experimental investigation and the results obtained from it, the work is concluded, as the percentage carbon fiber dosage increases, changes in various concrete properties are as follows,

i. Slump value of fresh concrete goes on decreasing as carbon dosage increases. Adhesive bond between fiber and concrete requires more amount of water than design in mix proportion. So as volume of fiber increases, water requirements increases to adopt the constant slump value.

ii. At various stages of curing, from results obtained, compressive strength of concrete showed the positive response of strength gain. While at 7 days and 56 days of curing, concrete shows the respond of strength gain up to 0.5% of carbon fiber and at 28 days, it showed at 0.5% carbon fiber. So, concrete with carbon fiber has a great response when carbon fiber percentage is in between of 0.5% to 0.6% of carbon fiber at various stages of curing.

iii. In the case of sulphate attack, immersion in the solutions causes a serious damage to the strength as well as reduction of weights at the end of sulphate curing. Strength reduction started from 3.55% at 7 days and it increases up to 10.25% at 28 days. But the increase in fiber content increases strength of concrete in such situations.

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