Effects of Acidic Curing on the Properties of Treated and Untreated Polyester Fiber Reinforced Concrete

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Abstract— fiber reinforced concrete is the mixture of concrete with discontinuous discrete fibers. Fibers in concrete increase the tensile strength and also reduce the growth of micro cracks in the concrete. Fiber reinforced concrete is very effective and economical process to enhance the physical and mechanical properties of the concrete. Polyester fiber is a synthetic resin in which the polymer units are linked by ester groups. Use of polyester as fibers greatly effects the properties of concrete, In this paper an attempt is made to review the effects of acidic curing on treated and untreated polyester fiber reinforced concrete and its properties.

Key words: Fiber Reinforced Concrete, Polyester Fiber, Acidic Curing, Compressive Strength, Flexural Strength, Split Tensile Strength

I. INTRODUCTION

Concrete is a mostly used material in construction industry. concrete has enough strength in compression but it is weak in tension hence it should be reinforced either with steel or different types of fibers so that tensile strength of concrete can be increased and to make concrete strong, durable and less susceptible to tension. Fiber reinforced concrete is the mixture of concrete with discontinuous discrete fibers [1]. There are various type of fibers like steel, glass, synthetic fibers such as polyester fibers, and coconut fiber is used in concrete. There are more possibility to use different material as fibers in concrete, polyester fiber is a synthetic resin in which the polymer units are linked by ester groups. Generally micro-cracks developed in the conventional concrete formerly the structure is loaded. There are many reasons of developing micro-cracks but some of them are drying shrinkage and other causes of volume change. As soon as the structure is loaded, developed micro-cracks open up and propagates which results in inelastic deformation of the concrete. Incorporation of polyester fiber to the concrete improves various properties of concrete like tensile strength, compressive strength, binding properties, micro cracking control and also increases spalling resistance. A problem of non-uniform distribution of polyester fiber is faced while using them as fibers in concrete but it can also be solved by treated polyester fibers. Acidic curing or acid rain affects the concrete in long term. When concrete is attacked by acidic currying or acid rain, neutralization reaction occurs between Ca(OH)2 and acid rain in the concrete. In this process of neutralization the pH value in the concrete drops and the calcium-silicate-hydrate (C-S-H) decomposition starts [2]. As the cement paste corrodes from the surface, sand and aggregates are exposed to corrode reinforcement bars. Finally the deterioration of the concrete starts. These processes are accelerated by cracks [3]. Fiber reinforced concrete minimizes the propagation of cracks and enhance the properties of the concrete.

II. MATERIALS

A. Cement

Ordinary Portland cement is used.

B. Water

Potable water or tap water is generally acceptable for mixing and curing concrete. Water used for mixing is checked to be free from oil, acid, organic materials etc. or other substances that may be harmful for concrete. Conforming to IS 456: 2000.

C. Fine Aggregate

Sand is used as a filler material in construction activities; generally sand passing through 2.36 mm IS sieve is taken. Sand having minimum 20 % fineness and washed is good for concrete.

D. Coarse Aggregates

The coarse aggregate used is 20mm in size, crushed angular shape and free from dust.

E. Polyester Fiber

Polyester is a category of polymers which contain the ester functional group in their main chain. The term "polyester" use for a specific material generally refers to polyethylene terephthalate (PET). Polyesters include naturally occurring chemicals, as well as synthetics through step-growth polymerization such as polycarbonate and polybutyrate. Generally natural polyesters and some of synthetic polyesters are biodegradable, but most synthetic polyesters are not [4].

III. MANUFACTURING PROCESS

The production of fibers reinforced concrete is based on mix design. Proportioning method is also used for lower grade of concrete. Concrete mixing is done with help of concrete mixing machine and manual mixing. Coarse aggregate, fine aggregate, and cement are taken in to mixer machine and mixed thoroughly. Manual distribution of hair is adopted to overcome the problem of non-uniform distribution of hair in concrete. Water was added steadily in mixer machine. Once the concrete is mixed thoroughly it is poured in the molds of cubes, cylinders and beams. It is taken care the inner surfaces of the molds were coated with oil before pouring so that they can be easily demolded after 24 hours. Concrete is poured in three layers and each layer is tamped 25 times with tamping rod and then vibrated for sufficient time. The top surface was levelled with trowel and finished properly. Once the concrete is set thoroughly, the cube, cylinders and

beams is demolded. To show the effect of Curing on fiber reinforced concrete normal water curing and acidic curing is done. Curing is the most important & sensitive factor that plays an important role on strength development and durability of concrete. Properly cured concrete has an adequate amount of moisture for continued hydration and development of strength, volume stability and resistance to freezing and thawing. In acidic curing concrete is not fully resistant to acids and most acids disintegrate the cement slowly or rapidly depending upon the type of pH value of acidic water. The solution used for acidic curing of concrete samples was prepared using concentrated HCl, which was diluted to obtain a pH of 4.5.

IV. TREATMENT

Generally the distribution of untreated fiber in concrete mix is not uniform. Treatment of fiber is done to minimize a problem of non-uniform distribution of fibers in the concrete. There are following methods of treatment of polyester fibers.

A. Treatment by NaOH

Treatment starts with the preparation of NaOH solution. 2% NaOH solution is prepared by dissolving 2gm of NaOH in 20-30ml (approximate) of distilled water and make up the volume of 100 ml. then the polyester Fibers are immersed in prepared 2% NaOH solution for 24 hours. After 24 hours the alkaline treated fibers are washed 2 to 3 time with distilled water until no alkali is present in the wash. After that washed fibers are oven dried at a temperature of 110-120oC for 2-3 hours [5].

B. Benzoyl-Peroxide-Treated

The Alkali Sansevieria cylindrica Fibers are immersed in 6% solution of benzoyl peroxide in acetone for 30 min. The solution is filtrated and the fibers are dried in air for 24 h [6].

C. Potassium-Permanganate-Treated

The Alkali Sansevieria cylindrica Fibers are immersed in 0.5% solution of potassium permanganate in acetone for 30 min. The solution is filtrated and the fibers are dried in air for 24 h [7].

D. Stearic-Acid-Treated

In all, 1% solution of stearic acid in ethyl alcohol is added drop-by-drop to the Alkali Sansevieria cylindrica Fibers placed in a stainless steel vessel with continuous stirring. These fibers are then dried in an air oven at 80oC for 45 min [6].

V. PROPERTIES

The use of treated and untreated polyester fibers in concrete under the effect of normal water curing and acidic curing greatly affects the properties of the concrete. Fibers in concrete control micro-cracks, improve tensile strength, compressive strength, binding properties. Compressive strength of concrete when polyester fibers are used up to 2.5% by weight of cement, is maximum. The effect of acidic attack due to acidic curing is found to be minimum on treated fiber reinforced concrete as compared with untreated fiber reinforced concrete. Compressive strength is also higher for normal water curing as compare to acidic curing. Split tensile strength of fiber reinforced concrete with fiber content 2.5% is more. Treated fibers enhance the split tensile strength as compare to untreated fibers. Flexure strength of fiber reinforced concrete is improve when fibers incorporate up to 2.5% after further increase in fiber percentage flexural strength decreases. Effect of acidic curing is least in treated fiber reinforced concrete. Workability of fiber reinforced concrete is significantly reduced up to 30% when polyester fibers are used.

VI. CONCLUSION

Following conclusion is drawn from the current study;

1) Treated and untreated polyester fiber incorporated up to 0.25%, increase the compressive strength up to 20% and 10% respectively with normal water curing while using acidic curing it increases up to 25% and 10%.
2) Incorporation of polyester fibers up to 0.25%, treated and untreated polyester fiber increase the split tensile strength up to 50% and 40% respectively with normal water curing while using acidic curing split tensile strength increases up to 55% and 40%.
3) The flexural strength of treated and untreated polyester fiber reinforced concrete improves by 20% and 8% respectively with normal water curing and by 44% & 33% respectively with acidic curing.
4) Effect of acidic curing, decrease the strength of fiber reinforced concrete 3% to 5% as compare to normal curing. Decrement in strength is also higher when untreated fiber reinforced concrete cured with acidic curing.
5) Optimum content of polyester fiber in concrete is 2.5% beyond 2.5% it adversely affect the fiber reinforced concrete.

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