Effect of Fly Ash on Fiber Reinforced Concrete-A Durability Approach

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Abstract: *This paper deals with investigation of durability tests on steel fiber reinforced concrete with fly ash.M25 grade concrete having mix proportion of 1:2.32:3.63 for concrete without fly ash and 1:2.27:3.55 for concrete with fly ash with w/c ratio of 0.49 were adopted in this work. Hooked end steel fibers of aspect ratio 60 were used with volume fraction of 2% were added in the concrete mix with partial replacement of cement with 40% fly ash. The durability test was conducted through chemical attack by immersing concrete samples in an acid solution. The cube specimen were tested after 28 days curing in water and compressive strength was determined and the cube sample with same mix proportion after 28 days of curing in water, kept immersed in 10% of sulphuric acid for 30 days and compressive strength were determined. The final results comprises of percentage loss of compressive strength. Steel fiber reinforced fly ash concrete (SRFC) shows less percentage loss in strength compared to steel fiber reinforced concrete (SRC) which is 15.4%.*

Key words: Hooked end steel fiber, Steel Fiber Reinforced Concrete (SRC), Steel Fiber Reinforced Fly Ash Concrete (SRFC), Aspect ratio.

I. INTRODUCTION

Fiber reinforced concrete is Portland cement concrete reinforced with more or less randomly distributed fibers to improve their properties. The primary role of adding fiber in concrete is to modify cracking mechanism. In present scenario, it is necessary to reduce the construction cost in one and other way. Cement is widely used and it is one of costly ingredient in production of concrete. Since, production of cement results in release of carbon dioxide. To overcome these difficulties, pozzolanic materials were widely used in concrete and also to modify some properties. Fly ash is one of the pozzolanic materials, which are an industrial by-product generated from combustion of coal in thermal power plants. The disposal of fly ash is one of the major issues for environmentalists as dumping of fly ash as a waste material may causes severe environmental problems. So, the fly ash as utilized in concrete as a supplementary material.

Durability and strength are important criteria for the design of concrete structure. Any deficiency in any of two i.e. durability and strength could make the structure unfit for the intended purpose. If the structure is not durable, but it has sufficient strength, then the strength of structure reduces with the age due to deterioration of concrete and reinforcement due to surrounding environment. One of the main causes of deterioration in concrete structures is the corrosion of concrete due to its exposure to harmful chemicals that may be found in nature such as in industrial effluents and sewage water. Sulphuric acid solution in sewage and waste water deteriorates concrete structures by reacting with cement hydrates. Engineers should strive to design both the concrete mix and structure to decrease the effect of acid attack. . Highly engineered concrete materials not only increase the mechanical properties, but also have high levels of durability.

2. MATERIALS

2.1. Cement

The cement used in this experimental work is OPC 53 grade coromandel king. The specific gravity of cement is 3.15.The standard consistency is 32.The initial and final setting times of cement are 65 minutes and 540 minutes.

2.2. Aggregate

The fine aggregate used is river sand and which is passing through 4.75mm was used in this work. The specific gravity of fine aggregate is 2.36 and fineness modulus of 3.2 and belongs to Zone-I. The coarse aggregate which passes through 20mm and retained on

4.75mm were used in this work. The specific gravity of coarse aggregate is 2.74 and fineness modulus 6.98.

2.3. Super plasticizer

Super plasticizer used is high range water reducers. The addition of super plasticizer results in reduction of water requirements. The name of super plasticizer added is CONXL PCE DM-01. The amount of super plasticizer used is 0.6% of weight of cement.

2.4. Fly ash

Fly ash used in powdered form and procured from thermal power plant at Ennore. Cement is replaced by 40% of Class F fly ash in this research work and the specific gravity is found to be 2.29.

2.5. Water

Portable tap water is used for concrete mix. The pH value of water used in the concrete mix is found to be 6.

2.6. Steel fibers

Hooked end steel fibers of length 3cm and equivalent diameter 0.5mm is used in this research work. The aspect ratio of steel fiber is 60.The volume fraction of steel fiber added is 2%.The quantity of steel fiber added is based on code IRC SP-046.

Figure 2.1: Hooked end steel fiber

3. METHODOLOGY

Fine aggregate and coarse aggregate mixed with the cement followed by 40% replacement of cement by fly ash. Super plasticizer is added with water. The water super plasticizer is added to cement-aggregate mixture. Finally the steel fibers were dispersed randomly in the concrete mix. The test sample is prepared by filling the concrete mix 150mmx150mmx150mm cube mould. After 24 hours of moist curing, the cube samples were removed from the mould and kept in curing tank. The cube samples were taken from curing tank for compression test, after 28 days and 56 days of curing. After 28 days and 56 days of curing, test samples were removed from the curing tank and surfaces were cleaned with a wire brush to remove loose materials from the test samples and were immersed in 10% of sulphuric acid solution for 30 days. After 30 days immersion of cube samples in acid solution, compression tests were conducted. Percentage loss in compressive strength was determined.

4. EXPERIMENTAL INVESTIGATION

4.1. Mix Design

M25 grade of concrete were designed as per IS 10262:2009;

Mix Proportion for Steel Fiber Reinforced Concrete

Cement=331kg/m^3

Fine Aggregate=769.01 kg/m^3

Coarse Aggregate=1202.76 kg/m^3

Water=162.19 kg/m^3

Super plasticizer=1.98 kg/m^3

Fiber=160 kg/m^3

Mix ratio=1:2.32:3.63

Mix Proportion for Steel Fiber Reinforced Fly ash Concrete

Cement=198.6 kg/m^3

Fly ash=132.4 kg/m^3

Fine Aggregate=769.01 kg/m^3

Coarse Aggregate=1202.76 kg/m^3

Water=162.19 kg/m^3

Super plasticizer=1.98 kg/m^3

Fiber=160 kg/m^3

Mix ratio=1:2.27:3.55

4.2. Test Results

The below tables shows the compressive strength of concrete cube samples consisting of without fly ash and without steel fiber (CC), without fly ash and with steel fiber (SRC), with fly ash and without steel fiber (FCC), with fly ash and with steel fiber (SRFC), after 28 days and 56 days of curing and also the compressive strength after 30 days immersion in acid solution and percentage reduction in compressive strength. The compressive strength is determined for every concrete cube samples and test results are compared and losses in percentage of compressive strength are determined.

Figure 4.1: Test sample testing in universal testing machine

Figure 4.2: Test sample after immersed in acid solution

Table 4.1: Test Results of Cube Samples

S.No	Test Specimen	Days of Curing	Compressive Strength after 28 days of Curing (N/mm^2)	Compressive Strength after 30 Days Immersion in Acid Solution (N/mm^2)	Loss in Compressive Strength (%)
1	without fly ash and without steel fiber (CC)	28	32.59	13.97	56.5
2	without fly ash and with steel fiber (SRC)	28	45.07	29.21	35.2
3	with fly ash and without steel fiber (FCC)	56	34.07	19.62	42.5
4	with fly ash and with steel fiber (SRFC)	56	45.35	38.36	**15.4**

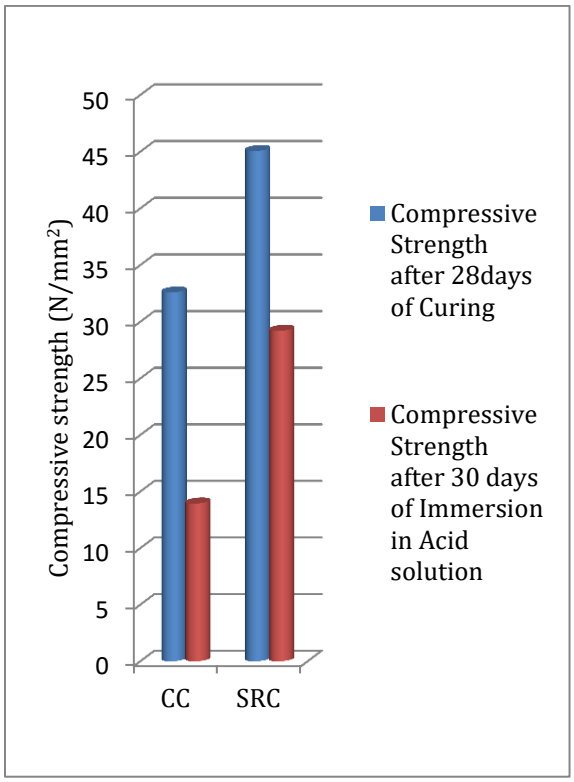

Figure 4.3: Chart Showing Comparison of test results

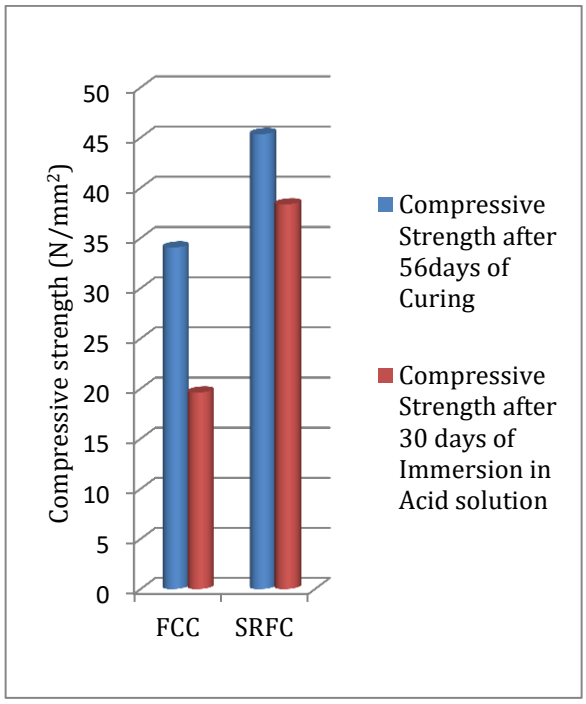

Figure 4.4: Chart Showing Comparison of test results

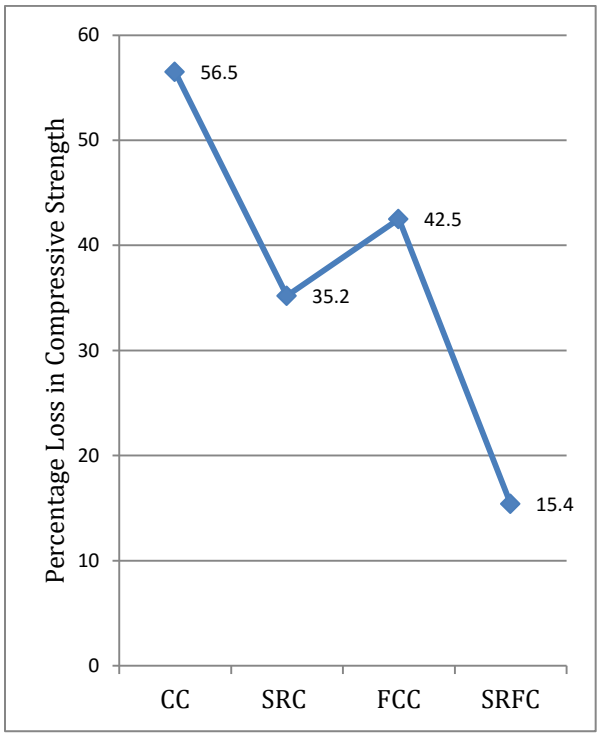

Figure 4.5: Chart Showing Percentage Loss in Compressive Strength of various Concrete Mixes

5. OBSERVATIONS

The Percentage loss in Compressive Strength for SRC is 38% less when compared with CC .The percentage loss in Compressive Strength for SRFC is 63.8% less when compared with FCC. The percentage loss in Compressive Strength for FCC is 25% less when compared with CC. The percentage loss in Compressive Strength for SRFC is 56.5% less when compared with SRC.

6. CONCLUSIONS

The behavior of concrete with and without steel fiber and fly ash immersed in sulphuric acid was studied in this research work. Based on the results obtained, the following conclusions are made;

- The target strength for concrete mix without fly ash attained at 28 days and target strength for concrete mix with fly ash attained only at 56 days.
- The concrete mix with 40% replacement of cement with fly ash and steel fiber shows less reduction in compressive strength compared to other concrete mix which is 15.4%.

- The concrete mix with 40% replacement of cement with fly ash and steel fiber is more resistant to acid attack. The addition of fly ash to concrete helps in resistant to acid.
- By using fly ash and steel fibers in the concrete mix, helps in increasing the life of the structures.

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