Sulfuric acid, Sulphate, and Alkali resistance of Self compacting concrete

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Abstract : ***This paper discuss assets chemical resistance test of self-compacting concrete made with different percentage of steel fibres and without steel fiber and fly ash. Three different mix designs are expressed to carry out this test. The cubes are cast and cured for 28 days in clean water and immersed in three different chemical solutions like 5% sulphate, 5% Alkali, and 5% sulphuric acid for a period of 50 days. After the 50 days period, percentage of weight loss and percentage of loss of strength in three different chemical like sulphate, Alkali, sulphuric acid attack are found out. The test results conclude that the specimens which are immersed in 5% sulphuric acid have created important damage. The weight loss and strength loss was found in Sulphuric acid immersion. The obtained values of the percentage strength loss were 19.4% 16.2% and 14.2% and weight loss 0.48% 0.45% and 0.43% respectively.***

IndexTerms - self-compacting concrete, chemical resistance test, Steel Fiber, Fly ash.

I. INTRODUCTION

To resist weathering action, chemical attack, of the structures built in the 1960s and 1970's have seriously deteriorated and substantial funding is now needed for maintenance and repair, in addition to new construction. The situation is compounded by the fact that concrete technology has changed significantly in the last 20 years. Tire introduction of high strength and high performance concretes has resulted in substantial changes in the mixture proportioning from the practices employed in the 1970,s. The durability of concrete has become a worldwide concern during the latter part of the 20" century. This paper discusses the chemical resistance study on Self compacting concrete using Steel fibre and Fly ash.

1.1 Durability of Concrete

Durability is defined as the ability of concrete resist weathering action, chemical attack, abrasion or any other process of deterioration while most import attaining its desired engineering properties. It normally refers to the duration or life span of trouble free performance. A durable concrete is one that performs satisfaction under anticipated exposure conditions during its life span. The material and mix proportions used should be such as to maintain its integrity and, if applicable, to protect embedded metal from corrosion. Even though concrete is a durable material requiring a little or no maintenance in normal environment but when subjected to highly aggressive or hostile environments it has been found to deteriorate resulting in premature failure of structures or reach a state requiring costly repairs. Durability of concrete its capability abrasion or any other process of deterioration. A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure condition during service (IS 456-2000).
When exposed to environment durable concrete is likely to retain its original form, quality and serviceability during its lifetime.
Durable concrete envisages limits for maximum water cement ratio, minimum cement content, cover thickness, and sulphates in concrete. (IS – SP – 28).

II. METHODS AND MATERIAL

2.1. Materials used

2.1.1. Cement

In this thesis work, the cement selected was ordinary Portland cement of 53 Grade (compressive strength53 MPa at 28 days) Test were completed as per IS:269- 1976 and IS 12269 – 1987. The most important types of cement are used in the components in the manufacture of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form strong building materials.

2.1.2 Fine aggregates

For the experiment of SCC, Generally we were used natural sands or River sands as fine aggregates in concrete. For tested. These contain of crushed stones which pass through 9.5mm sieve. The specific gravity, Fineness modulus and Bulk density Properties of the fine aggregates are 2.64 and 2.50 and 1562, respectively.

2.1.4. Fly ash

class F, Fly ash was obtained from Thermal power plant Ambuja, Surat.has the specific gravity of 2.85.

2.1.5. Hooked Steel fibres

In this paper work ,the fiber selected was Hook steel fiber. The hooked steel fibres having aspect ratio – 60, length 30 mm, diameter 0.5 mm. were used in this thesis.

2.1.6. Admixture

Plasticizers help us in increasing the workability of concrete without addition of water. It means that we can reach lower water/powder ratio without reducing the workability at the same cement content.

2.1.7. Water

In this thesis, tank clean water was used for mixing and curing purposes.

2.2. Mixture proportioning

For the Tests, Self Compacting Concrete mixture was collected of Portland cement Grade 53, fly ash class F, coarse aggregates, fine aggregate, Hooked steel fibres, water and super plasticizer. Three Self Compacting Concrete mixes (SCC1,SCC2,SCC3) were prepared, and their quantities of SCC mixtures are shown in Table 1.

2.3. Casting and curing

The preparation of the concrete mix was done by mixer machine on the LAB. mixing was done for 30 s in dry form. The total mixing time was 5 min. for fresh concrete properties, The concrete mixture was then used to carry out for Tests. The specimens mould were opened after 24 h and placed in water for 28 days curing testing and dry for one day were immersed in 5% acid added water for 50 days.

2.4. Fresh properties of SCC

Self Compacting Concrete different from the another types of concrete by the placing method. The concrete is categorized as SCC by pleasing three requirements. passing capability filling capability, and segregation resistance. The basic tests such as slump test, J-ring test, V funnel test for filling ability, L-box and U-box test for passing ability, were conducted.

III. RESULTS AND DISCUSSION

3.1. Fresh concrete properties

Fresh state properties of concrete were measured by the tests of Slump flow (mm), V-funnel (s), L-box (H2/H1), U-box (H1–H2), J–Ring (mm), flow passing capability, and SCC having different percentages of steel fibres. The result as shown in Table 2 It was experiential that addition of steel fibres in concrete mix decreased the workability. All fresh concrete assets tests are in high- quality conformity as per European procedure, EFNARC and Indian.

Table. 1 Mix proportions of different SCC mixes.

Mix ID	Cement (kg)	Fly ash (%)	Fly ash (kg)	Steel fibre (%)	Steel fibre (kg)	Sand (kg)	CA (kg)	Water (kg)	w/p	SP (%)	SP (kg)	Density (kg/m3)
SCC1	425	15	75	0	0	905	585	209	0.42	1.3	6.5	2205.5
SCC2	425	15	75	0.5	35	905	585	209	0.42	1.3	6.5	2240.5
SCC3	425	15	75	1.2	85	905	585	209	0.42	1.3	6.5	2290.5

Table. 2 Properties of fresh concrete mixes with and without steel fibres

Mix ID	Steel fibre (%)	Slump flow (mm)	V-funnel (s)	L-box (H2/H1)	U-box (H1–H2)	J–Ring (mm)
SCC1	0	710	8	0.97	10.4	8
SCC2	0.5	691	9	0.9	19	6
SCC3	1.2	665	11	0.8	29	5
Range (EFNARC, 2005)	-	640-800	6-12	0.8-1	0-30	0-10

3.2. Resistance to Acids

OPC cement paste have alkaline material that is generally resistant to acids. Protecting coverings should be applied to the surface of concrete that is likely to be exposed to acid solutions having a p h of 5.5 or lower. The action of sulphuric acid on concrete is high and a special situation. Concrete in sewer lines and in chimneys where fuels containing sulphur are used, will sometimes be exposed to sulphuric acid. Both laboratory test and field experience have shown that the use of sulphate resistance concrete will improve its performance when exposed to sulphuric acid. act of sulphuric acid on concrete occurs in two steps. The acid reacts with calcium in the cement paste to form calcium sulphate. The calcium sulphate diffuses in tot he concrete, which can cause expansion and cracking.

3.2.1 ACID ATTACK TEST FOR Percentage OF WEIGHT LOSS

- The specimen will be processed for Acid attack factor after completion of 50 days acid curing.
- Acid attack factor mostly deals with weight loss and dimension loss of specimens.
- The deteriorated surface dimensions are taken by calculating Diagonal dimensions of each struck face is taken eight corners of set of cubes.
- The final weight of cube was taken and to calculate the percentage of weight loss.

3.2.2 ACID DURABILITY FACTOR FOR percentage STRENGTH LOSS

In Acid durability test, the deteriorated cube was tested for compressive strength for 28 days clean water curing immersing and after 50 days acid curing. Found strength before acid attack and after acid attack and compare together.

3.3 Experimental Program

3.3.1 sulphuric acid Attack Test

Procedure,Acid resistance was tested on 150 × 150 × 150 mm size cubes are cast for three different mix proportions using fly ash, steel fiber, cement, coarse aggregate, fine aggregte. The investigations were carried out for different properties such as strength and chemical resistance.

The cube specimens were weighed after 28 Days curing and allowed to dry for one day. After immersed in 5% solution of sulphuric acid.Then the specimens were taken out from the acid solutions and the surfaces of specimens were cleaned and weight and compressive strength of specimens were found out and thus the average loss of weight and The cube specimens were weighed after 28 Days curing and allowed to dry for one day. After immersed in 5% solution of sulphuric acid.Then the specimens were taken out from the acid solutions and the surfaces of specimens were cleaned and weight and compressive strength of specimens were found out and thus the average loss of weight and compressive strength were calculated. The solution is replaced at regular intervals to most import attain concentration of solution throughout the test period. solution for acid resistance test for 50 days continuously. The results are compared and arranged with percentage

loss of weight, percentage loss and percentage loss of strength. Also the graphical representation of the results and the test photograph is shown in fig4,table3.

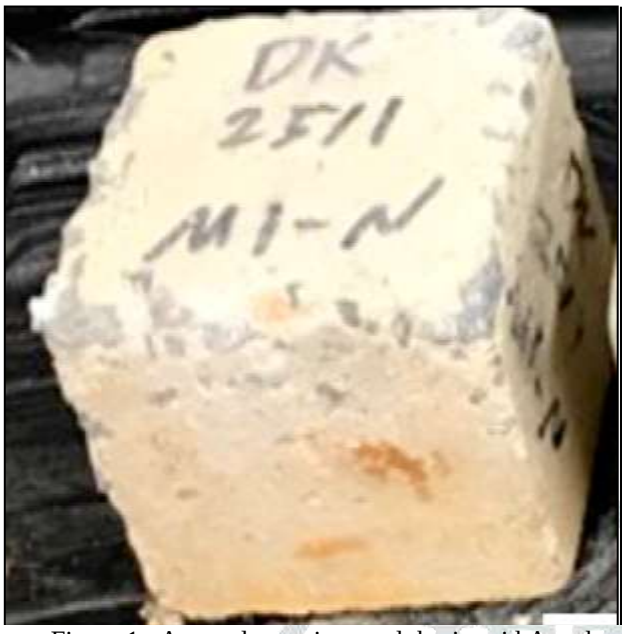

Figure 1: A sample specimen sulphuric acid Attack

Figure 2: A sample specimen Alkali Attack

3.3.2 Alkali Attack Test

To determine the resistance of various concrete mixtures to alkali attack, the residual compressive strength of concrete mixtures of cubes immersed in alkali water having 5% of sodium hydroxide (Na OH) by weight of water was found. The concrete cubes which were cured in water for 28 days were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. Then the cubes were immersed in alkali water continuously for 50 days. After 50 days of immersion, the concrete cubes were taken out of alkali water. Then, the specimens were tested for compressive strength. The resistance of concrete to alkali attack was found by the percentage loss of weight of specimen and the percentage loss of compressive strength on immersion of concrete cubes in alkali water. Table5:23 represents the Percentage loss in Weight of self compacting concrete due to Alkality respectively. Table 4 shown the Percentage loss in Strength of self compacting concrete due to Alkali attack.

3.3.3 Sulphate Attack Test.

The resistance of concrete to sulphate attacks was calculated by determining the loss of compressive strength or difference in compressive strength of concrete cubes immersed in sulphate water having 5% of sodium sulphate (Na2SO4). The concrete cubes of 150mm,150mm,150mm size after 28 days of clean water curing and dry for one day were immersed in 5% Na2SO4 added water for 50 days. The concentration of sulphate water was maintained throughout the period. After 50 days immersion period, the concrete cubes were removed from the sulphate waters and after wiping out the water and girt from the surface of cubes tested for compressive strength following the procedure prescribed in IS: 516- 1959. table 5 represents the Percentage loss in strength of self compacting concrete due to Sulphate respectively.

Figure 3: A sample specimen Sulfate Attack

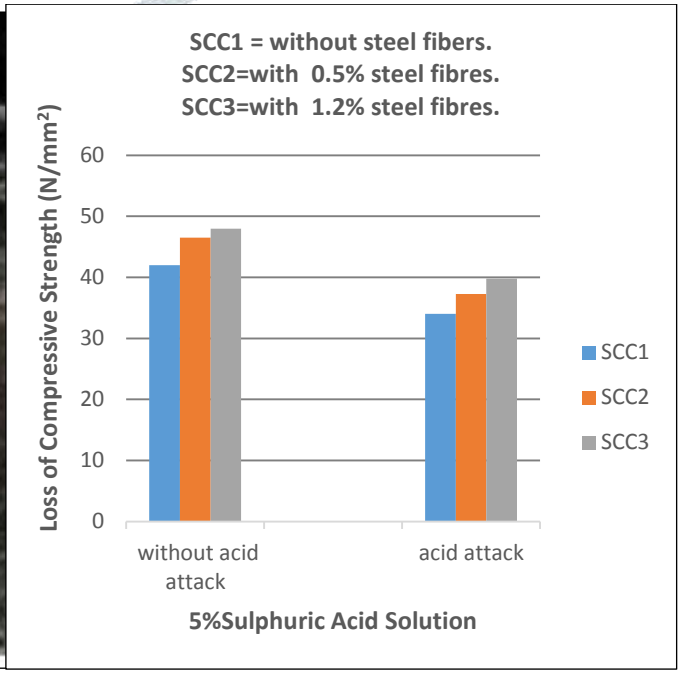

Fig. 4. Loss of Strength for SCC1,SCC2,SCC3 sulphuric solution.

3.4 Results

3.4.1 Sulfuric acid(H2SO4) Result

at the age of 28 days before sulphuric acid attack, compressive strength for mixes SCC1,SCC2,and SCC3 were 42 N/mm^2 46.52 N/mm^2 and 48 N/mm^2 respectively. at the age of 50 days after sulphuric acid attack 5%,The concrete mixes SCC1 SCC2 and SCC3 exhibited decrease in compressive strength by 19.4% 16.2% and 14.2% respectively. Also exhibited decrease in weight by 0.48% 0.45% and 0.43% results are shown in Fig.4

3.4.2 Alkali result

The compressive strength outcomes of Self compacting concrete at the age of 28 days before Alkali attack, compressive strength for mixes SCC1,SCC2,and SCC3 were 42 N/mm^2 46.52 N/mm^2 and 48 N/mm^2 respectively. at the age of 50 days after 5 % Alkali attack The concrete mixes SCC1 SCC2 and SCC3 exhibited decrease in percentage loss of compressive strength by 8.3% 6.81% and 7.2% respectively. Also exhibited decrease in weight by 0.31% 0.22% and 0.1% . results are shown in Fig.5

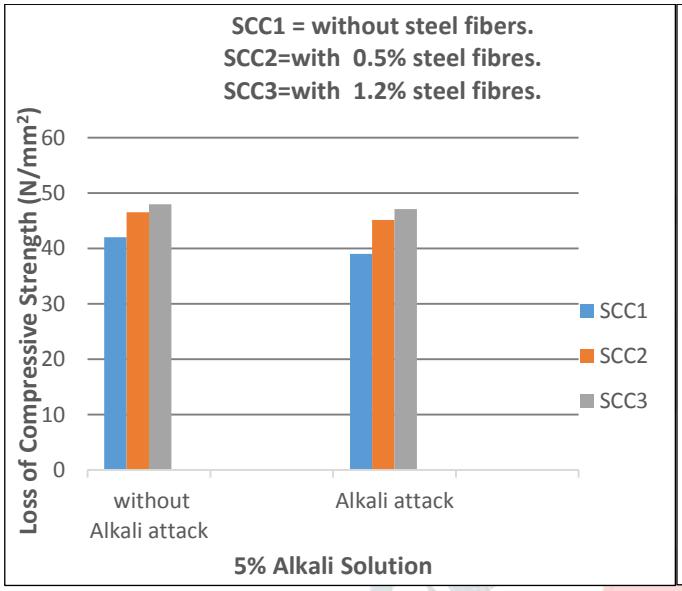

Fig. 5. Loss of Strength for SCC1,SCC2,SCC3, 5% Alkali Solution.

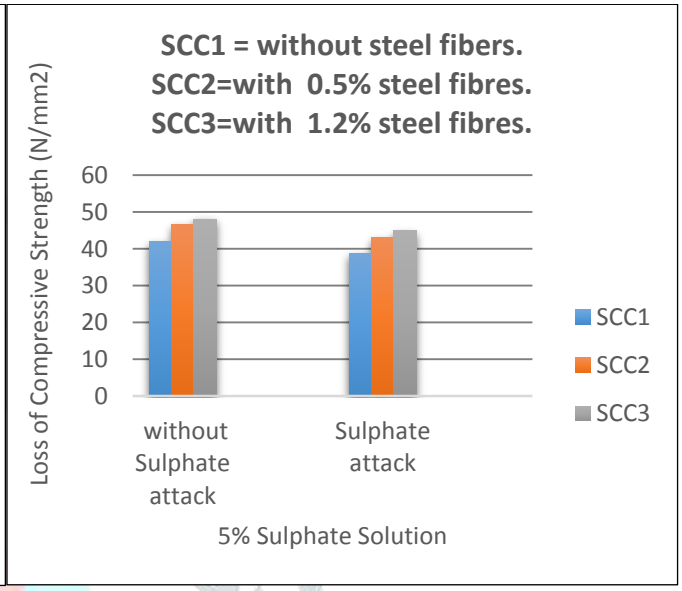

Fig. 6. Loss of Strength for SCC1,SCC2,SCC3, 5% Sulphate Solution.

Table 3 Chemical resistance test 5% Sulphuric acid solution (H2 SO4)

Mix ID	Steel fibre (%)	Loss of weight %	Compressive Strength for 28 days (N/mm^2) without Acid attack	Percentage reduction in compressive strength compared to 50 day strength, with acid attack
SCC1	0	0.48	42	19.4
SCC2	0.5	0.45	46.52	16.2
SCC3	1.2	0.43	48	14.2

Table 4 Chemical resistance test 5% Alkali solution

Mix ID	Steel fibre (%)	Loss of weight %	Compressive Strength for 28 days (N/mm^2) without Alkali attack	Percentage reduction in compressive strength compared to 50 day strength, with Alkali attack
SCC1	0	0.31	42	8.3
SCC2	0.5	0.22	46.52	6.81
SCC3	1.2	0.1	48	7.2

Table 5 Chemical resistance test 5% Sulphate solution

Mix ID	Steel fibre (%)	Loss of weight %	Compressive Strength for 28 days (N/mm^2) without Sulphate attack	Percentage reduction in compressive strength compared to 50 day strength, with Sulfate attack
SCC1	0	0.26	42	9.7
SCC2	0.5	0.12	46.52	7
SCC3	1.2	0.11	48	6.91

3.4.3 Sulphate result

The compressive strength results of SCC at the age of 28 days without Sulphate attack, compressive strength for mixes SCC1,SCC2,and SCC3 were 42 N/mm^2 46.52 N/mm^2 and 48 N/mm^2 respectively. at the age of 50 days after 5 % Sulphate attack The concrete mixes SCC1 SCC2 and SCC3 exhibited decrease in percentage loss of compressive strength by 9.7% 7% and 6.91% respectively. Also exhibited decrease in weight by 0.26% 0.12% and 0.11% . results are shown in Fig.6

IV. CONCLUSION

As a final point based on the results obtained and interpretation the following conclusions be able to drawn from this study:

- There is less effect for the Self compacting concrete specimens immersed in 5% sulfate and 5% Alkali solutions.
- Specimens immersed in 5% Sulfuric acid have a significant damage in loss of strength and loss of weight.
- High dosage of chemical solutions is used because; the testing is carried out for short period (50 days) due to time constraint.
- Self compacting concrete specimens have shown a better resistance towards chemicals against sulfate and Alkali.
- The weight loss and strength loss was found in Sulfuric acid immersion. The obtained values of the percentage strength loss were 19.4% 16.2% and 14.2% and weight loss 0.48% 0.45% and 0.43% respectively.

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