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An Experimental Study Of Effects Of Admixture On Self Compacting Concrete

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Abstract: This paper presents a preliminary consider on self compacting concrete (SCC). SCC is a spilling strong mix, that can join under its very individual emerge weight. The basic fluid nature of SCC makes it sensible for putting in gravely structured conditions and in zones with a blocked stronghold. Fly ash can be used as a mineral admixture in concrete. Substitution of fly ash stays to bond in concrete. It is a widely adopted construction practice underlain by the aim to reduce CO_2 emissions of cement production. In this examination, cement, fine aggregate, coarse aggregate, water and fly ash materials are used to prepare the SCC. Fly ash replaced with 15%,25%,35%and 45%., with the help of polycarbonic ether based superplasticizer and viscosity modifying admixture to achieve fresh properties of SCC. By using M60 Grade concrete the examinations had carried out by adopting an optimum water-cement ratio. Workability tests on the fresh concrete by using slump flow, T50, V funnel, L box, U box tests and the durability of concrete is tested by chloride attack and sulphate attack at 90 days.

Keywords: Fly Ash, T_{50} test, L box, U box, V funnel, strength properties, durability properties.

1. INTRODUCTION

Self compacting concrete (SCC) is a moderate concrete that does not require any mechanical vibration for compaction. It can flow under its weight to fill in formwork and may achieve full compaction in the presence of congested reinforcement. As per EFNARC guidelines for SCC mix design. One of the most important differences between SCC and conservative concrete is the integration of a chemical admixture. Cement is the most expansive component in concrete, reducing cement content is an economical solution. The mineral admixture can improve particle packing and decreases the permeability of concrete. Fly ash is an industrial wastage, which improves strength and durability characteristics. Concrete which segregates will lose strength and results in honeycombed areas next to the formwork. A well designed SCC mix does not segregate, has high deformability and excellent stability characteristics. Self compacting concrete (SCC) owns over three main properties are Filling Ability, passing ability, segregation resistance. Highly useful water reducing agents (super plasticizers) are mostly affected these properties, this is usually based on poly-carboxylic ethers. The powder contents of SCC are normally lying above those of conventional concrete. In India, there is requirement of aggregates, mostly used for road and concrete constructions. Mainly aggregates occupy 70% of concrete. But in present, people are facing a problem due to a shortage of fine aggregate. Fly ash is a petroleum combustion product that is calm of the particulates (fine particles of burned fuel) that are driven out of gas-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. In the past, fly ash was generally released into the atmosphere, but air pollution control standards now required captured prior to release by proper pollution control equipment.

2. EXPERIMENTAL PROGRAM

2.1 Material properties

Ordinary Portland cement is (like ASTM Type I) conforming to the necessities of IS: 12269 (53 grade) was used. Fly ash is remains meeting the essentials of ASTM C 618 (Class F) were used. 12 mm size coarse aggregates are used and naturally available fine aggregates are used. The coarse and fine aggregate specific gravities are 2.79 and 2.60 respectively. A polycarboxilic-ether type super plasticizer (SP) with a specific gravity is 1.09, and viscosity modifying agent (VMA) with a specific gravity is 1.03.

Table1: Chemical composition of cement, fly ash

Chemical composition	Cement	Fly ash
Silica	21.76	58.28
Alumina	6.57	31.73
Ferric oxide	4.17	5.85
Calcium oxide	60.13	1.96
Magnesium oxide	2.09	0.13
Sodium oxide	0.34	0.75
Potassium oxide	0.45	0.76
Sulphuric anhydride	2.18	0.14
Loss on ignition	2.31	0.32

Table 2: Physical properties of Cement & fly ash

Property	Cement	Fly Ash
Specific gravity	3.12	2.34
Fineness modulus	5%	15%

Table 3: Physical properties of coarse & fine aggregates

Property	Fine aggregate	Coarse aggregate
Specific gravity	2.6	2.79
Fineness modulus	2.81	2.61

Super plasticizer i.e., Master Glenium Sky B233 is an admixture, it is highly flowable plasticizer, in SCC this is the most useful components. Master Glenium sky B233 is free of chloride and low alkali content.

Table 4: Properties of Master Glenium Sky B233

Aspect	Light brown liquid
Relative density	1.09+0.01 at 25^{o}C
pH	>6
Cl^- content	<0.2%

In the self-compacting concrete mix, if water content increases which lead to unprotected against moisture variations and segregation may occur. VMA also reduce bleeding from the concrete mix.

Table 5: Properties of VMA

Appearance	Yellowish to Brownish liquid
Specific Gravity @ 270 C	1.03 - 1.07
pH	Minimum 6.0
Chloride ion content	Nil (As per BS:5075 Part I)
Alkali content	Should not be more than 1g Na_2O equivalent / liter of admixture

3. MIX PROPORTION DETAILS

In our project 4 concrete mixes are prepared, which are having a cement substance of 550 kg/m^3, coarse aggregate of 901 kg/m^3 and fine aggregate of 840 kg/m^3, the w/c ratio was taken 0.3 by weight. The aggregates are taken as 50% of the overall volume of aggregates. The different self compacting concrete mixes are prepared by replacing cement with fly ash of 10%, 20%, 30% and 40% by weight of total binder content. The mix details are shown in table 6.

Table 6: various mixes for self compacting concrete

Mix	Cement (kg/m^3)	Fly ash (kg/m^3)	Fly ash (%)	Coarse aggregate (kg/m^3)	Fine aggregate (kg/m^3)	Water (kg/m^3)	Super plasticizer (%)	w/c	VMA (%)
SCC1	495	55	15	901	840	165	1.80	0.3	0.6
SCC2	440	110	25	901	840	165	1.80	0.3	0.6
SCC3	385	165	35	901	840	165	1.80	0.3	0.6
SCC4	330	220	45	901	840	165	1.80	0.3	0.6

4. PREPARATION AND CASTING OF SPECIMENS

The required quantities of materials are taken. Cement & fly ash are first mixed in dry state separately. The coarse aggregate and fine aggregate are mixed at dry and then mixed together in a mixer to form an identical mix, after adding water with Super plasticizer & VMA. Cast the specimens after to complete the tests for fresh properties. The cube size is 150 mm, to find out the compressive strength of the cube. The size of the cylinders is 150*300 mm, to find out the splitting tensile strength of cylinder and the beam size is 500*100*100mm, to find out the flexural strength of the beam.

5. TEST FOR SPECIMENS

5.1 Properties of fresh concrete

To determine the self-compacting ability properties i.e

1. Slump flow
2. L-box
3. V-funnel
4. U- box

The slump flow is found out the mean diameter of the mass of concrete. V funnel test flow time is < 6 sec, they recommend for a highly performed SCC. The L box and U box are regulating to check the filling ability of concrete

Table 7: Different types of fresh properties for SCC mixes

Mix proportions	Slump flow Diameter(mm)	L box (H_2/H_1)	U box (H_1-H_2) (mm)	V funnel T_{5min}(s)
SCC0	680	0.85	10	7.5
SCC1	650	0.87	15	8.1
SCC2	672.5	0.9	20	4.3
SCC3	690	0.93	17	5.5
SCC4	610.5	0.88	12	6.1

5.2 Strength and durability studies

Compressive strength test for the cubes at 7, 28 and 90 days, and split tensile strength test at 7, 28 and 90 days and flexural strength test at 7, 28 and 90 days. The sulphate attack and chloride attack was tested by calculating the weight losses of the cubes at 90 days. For studying durability characteristics of SCC 5% of H_2SO_4 and 5% of HCl solutions were used and specimens were placed up to an exposure time of 90 days.

6. RESULTS AND DISCUSSIONS

6.1 STRENGTH PROPERTIES

6.1.1 Compressive strength

As fly ash changes with an increment of 10 – 40%, the compressive strength is increased from 47.36 to 48.12MPa at 7 days, 70.76 to 72.90MPa at 28 days. The percentage of fly ash content increases then alternatively increases the strength of the mixes up to 30%. From 30% onwards by increase in fly ash content there is decrease in strength and also by increasing the water to cement ratio. SCC3 (30% fly ash) gained strength of 52.45 and 75.69 at 7 and 28 days. The values are given below

Table 8: Compressive strength for SCC mixes

Mix proportions	Compressive strength (MPa)		
	7days	28days	90days
SCC0	45.80	69.23	70.96
SCC1	48.46	70.36	72.83
SCC2	50.21	74.23	75.21
SCC3	53.12	76.28	78.48
SCC4	49.26	72.83	73.98

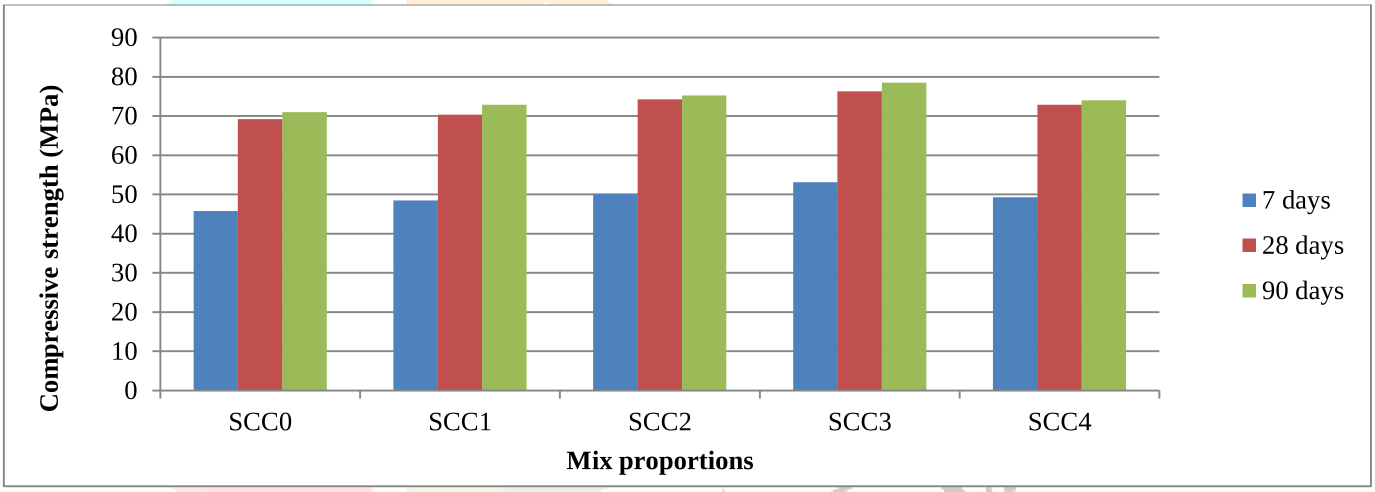

Fig: 1 Compressive strength values for SCC mixes

6.1.2. Split tensile strength

Splitting tensile strength values for SCC mixes obtained 3.41, 3.85, 3.98, 4.23, 3.89 MPa at 7 days. 4.56, 4.72, 5.03, 5.30, 5.19 MPa at 28 days. Fly ash changes with an increment of 10% to 40%. By increase in fly ash content from 10% to 40%, SCC3 (30% fly ash) gained strength of 5.30 MPa at 28 days. Similarly, SCC2 (20% fly ash) gained strength subsequent to 5.03 MPa at 28 days. Tensile strength increases, when decreasing the fly ash content.

Table 9: Tensile strength values for SCC mixes

Mix proportions	Split tensile strength (MPa)		
	7days	28days	90days
SCC0	3.52	4.81	6.32
SCC1	3.98	4.93	6.58
SCC2	4.16	5.05	6.98
SCC3	4.33	5.28	7.30
SCC4	4.02	5.12	6.82

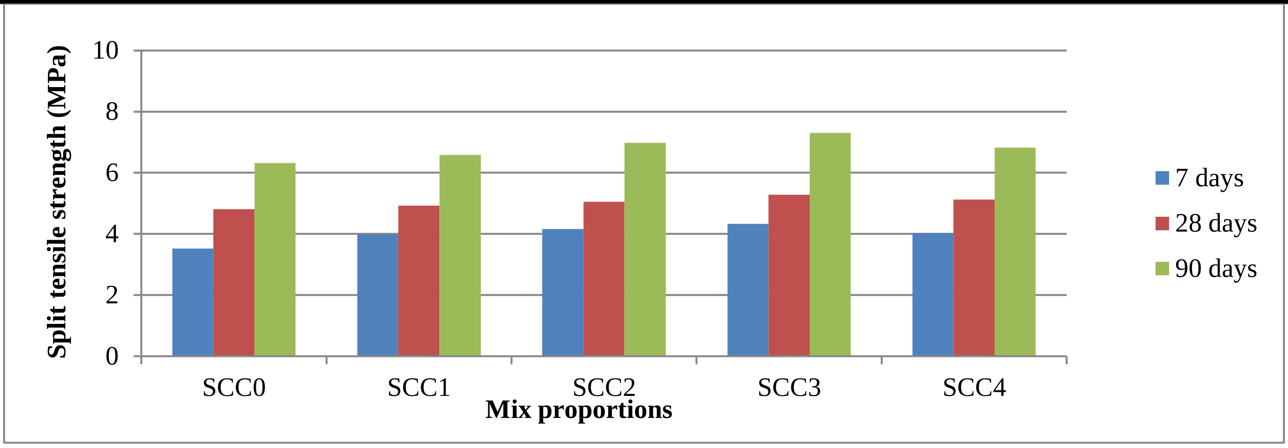

Fig: 2 Split tensile strength values for SCC mixes

6.1.2 Flexural strength test

Flexural strength increases from SCC1 to SCC3 and decreases from SCC4. The fly ash content is increases from 10% to 40%. Fly ash content is increases for mix SCC1 strength increases up to 5.40 MPa at 28 days. The fly ash content is increases from 10% (SCC1) to 40% (SCC4), SCC3 (30% fly ash) mix was gained optimum strength 6.90 MPa at 28 days. Similarly, SCC2 (20 % fly ash) attained strength subsequent to 5.73 MPa at 28 days. As increasing of fly ash content,
(From 30%) then decrease tensile strength at all ages of concrete.

Table 10: Flexural strength values for SCC mixes

Mix proportion	Flexural strength (MPa)		
	7days	28days	90days
SCC0	4.65	5.38	7.18
SCC1	4.98	5.61	7.48
SCC2	5.10	5.95	7.89
SCC3	5.56	7.10	8.10
SCC4	5.23	6.23	7.96

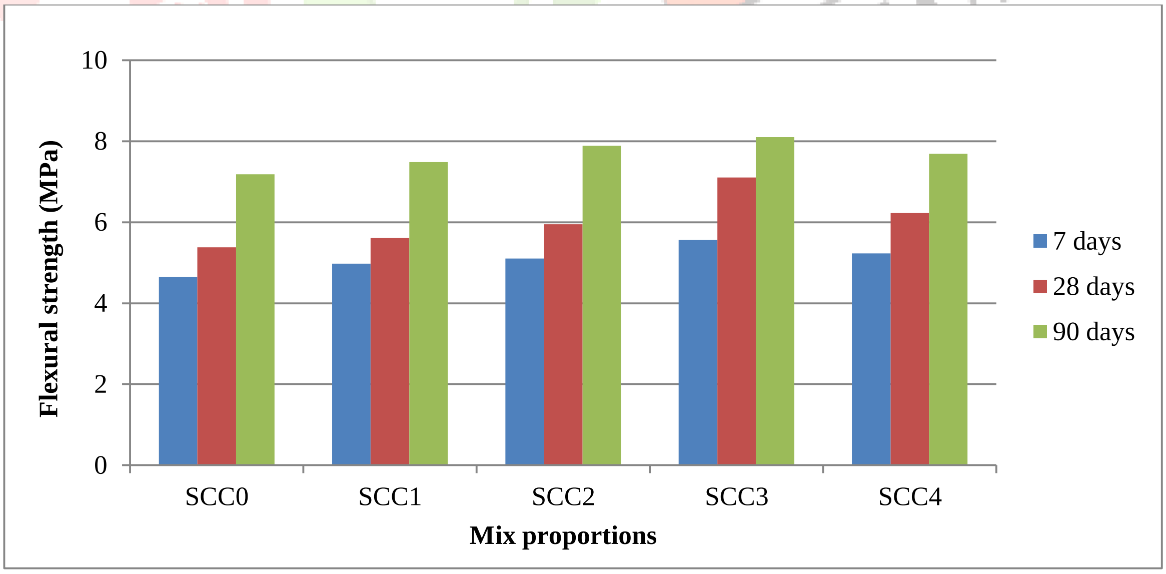

Fig 3: Flexural strength for SCC mixes

6.2 DURABILITY PROPERTIES

6.2.1 Chloride attack

Percentage of strength loss and weight loss of the cubes were found out at the period of 90 days curing. By increase the fly ash content the weight has been reduced for the concrete specimens and the compressive strength is also reduced.

Table 11: Variation between % of strength loss and % of weight loss at 3% HCl

Mix proportions	Average reduction in weight (%)	Average compressive strength (MPa)	Average loss of compressive strength (%)
	90days	90days	90days
SCC0	4.95	67.76	3.40
SCC1	4.74	70.12	3.14
SCC2	3.70	72.43	2.68
SCC3	3.55	75.89	2.58
SCC4	4.65	71.41	2.77

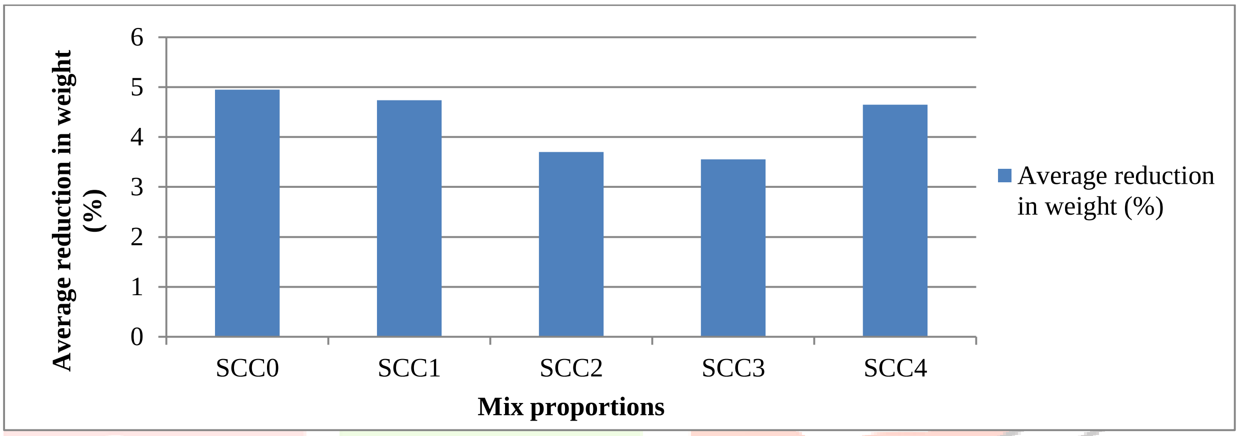

Fig 4: % of weight loss at 3% HCl

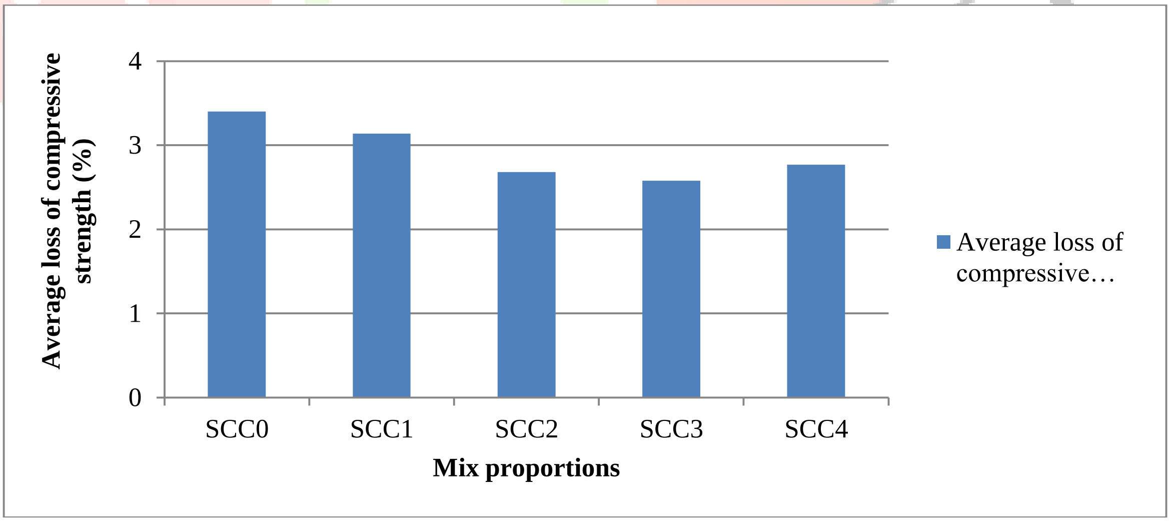

Fig 5: % of strength loss at 3% HCl

6.2.2 Sulphate attack

Sulphate attack was evaluated to find the losses in weight of the cubes at 90 days.

Table 12: Variation between % of strength loss and % of weight loss at 3% H_2SO_4

Mix proportions	Average reduction in weight (%)	Average compressive strength (MPa)	Average loss of compressive strength (%)
	90days	90days	90days
SCC0	3.34	67.10	4.34
SCC1	3.05	69..71	3.74
SCC2	2.90	72.06	3.12
SCC3	2.56	75.75	272
SCC4	3.04	71.16	

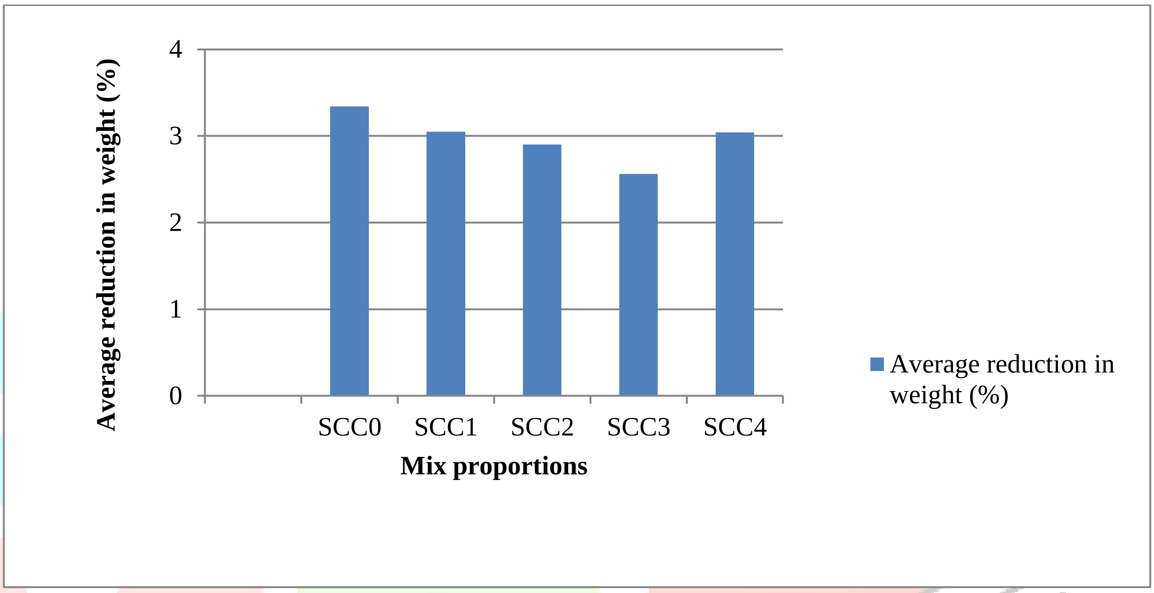

Fig 6: % of weight loss at 3% HCl

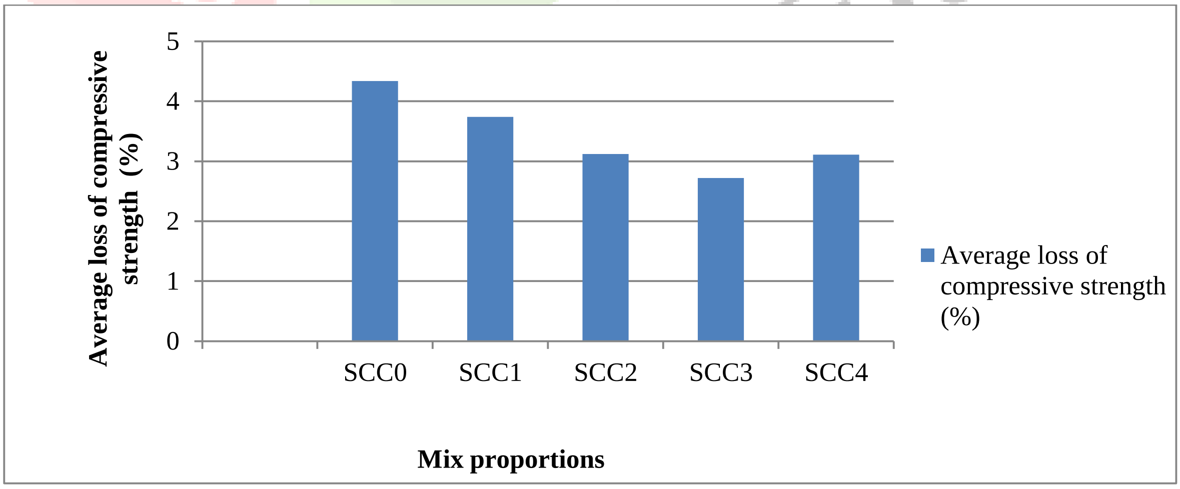

Fig 7: % of strength loss at 3% HCl

7. CONCLUSIONS

1. The fly ash replacement in around 35-45% will be given superior performance for SCCs.
2. Fresh properties of SCCs are effectively satisfied with in the limits of EFNARC-2005 guide lines.
3. Strength increases with the decrease of water to cement ratio (w/c), and achieved good strength w/c at 0.3.
4. The optimum strength is obtained at 35 % of fly ash replacement, by taking 50% of coarse aggregate and 50% fine aggregate.
5. At 35% replacement of cement by fly ash the optimum compressive & split tensile strength is obtained at 1.8% of super plasticizer.
6. Compressive strength is increased 15.98% at 7 days and10.18% at 28 days when compared to conventional concrete.
7. Split tensile strength is increased 23.07% at 7 days and 9.77% at 28 days when compared to conventional concrete.
8. Flexural strength is increased19.56% at 7 days and 28.02% at 28 days when compared to conventional concrete.
9. There is an increase in compressive strength, for partial replacement of cement with SP is up to 9.52% for 90 days.
10. There is an increase in split tensile strength, for partial replacement of cement with SP is up to 15.50% for 90 days.
11. There is an increase in flexural strength, for partial replacement of cement with SP is up to 12.81% for 90 days.
12. Durability test results show a reduction in compressive strength by 9.0% tested against 3% HCl.
13. Durability test results show a reduction in compressive strength by 11.2% tested against 3% H_2SO_4.

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