STRENGTH AND DURABILITY STUDY OF HIGH STRENGTH CONCRETE INCORPORATING AQUEOUS EXTRACT OF OKRA AS A BIOADMIXTURE ALONG WITH SILICA FUME

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Abstract : In the present era concrete is the most used material after water in developing countries. The huge demand of concrete require large amount of cement for the strength development of concrete. However the production of cement an essential basic of concrete releases large amount of CO_2. So there is a need of alternative material which can replace cement. In addition to the regular ingredient several other additive or admixture are added in concrete to enhance its properties. Moreover the use of various synthetic admixture in concrete has been proved to contribute largely to the emission of toxic specimen into the atmosphere. With this motivation in the present experimental work we have studied the suitability of a bio extract derived from a commonly vegetable such as okra for use as an admixture with and without silica fume in the production of concrete. Fresh properties like workability and hardened properties like compressive strength and durability have been carried out. The bio admixture was used in the ratio of 1:45, 1:30, 1:15(1g okra=45ml water). The percentage replacement of silica fume are 5%, 10%, 15% by weight of cement. Interaction of bio admixture were also investigated by using FTIR spectroscopic methods. FTIR spectroscopic indicates pectin is a major compound present in okra extract. Comparative analysis of fresh and hardened properties of using bio admixture with and without silica fume has been carried out which shows initially the replacement of okra extract with and without increases the strength and durability. From this study it has been found that optimum replacement of okra was 1:15 with 15% silica fume respectively. The addition of okra extract 1:15 with silica fume showed increase in compressive strength up to 14.214 % respectively. The result showed that there is a good scope of using okra extract with silica fume in concrete industries.

***Index Terms* – Bio Admixture, Okra, Silica Fume, Compressive Strength, Durability**

I. INTRODUCTION

Today concrete is the top most demanded material in the construction world. As day by day increasing construction so concrete demands the large amount of production of cement. Concrete is widely used construction material all over the world for various types of structures due to its strength and stability. The cement, fine and coarse aggregate are main ingredients of concrete and plays important role in the durability and strength of structures. The Portland cement is one of the primary ingredients utilization for generation of cement causes natural issues includes emission of co2 in the environment that leads to global warming.In addition to the regular ingredients, several other additives or admixtures are added to concrete in other to enhance its properties. Moreover, the use of various synthetic admixtures in concrete has been proved to have contributed largely to the emission of toxic species into the atmosphere. The term bio admixture is generally used to refer biopolymers and organic admixtures produced by bio-technological processes. However, compared to the other parts in the world, the amount of fruitful works done on the uses of bio based admixtures in concrete productions in India can be described as meager. With this motivation, we have studied the suitability of a bio extract derived from a commonly available vegetable, for use as an admixture in the production of sustainable concrete.

II. METHODOLOGY

The plant extract examined to use as bio-admixture was derived from a commonly available vegetable, okra or bhindi. In this investigation, three different doses of aqueous extract were prepared – 1:15, 1:30, and 1:45. For preparation of extract, only pod and seed parts of okra were used. The vegetable was first weighed, cut into small pieces, and then introduced in a beaker containing normal tap water in the predefined ratio. For example, 1:15 was prepared by extracting from 1g vegetable using 15 mL water. Thereafter, the mix was stirred thoroughly for 5 minutes and then left to stand undisturbed for 2 to 3 hours. Subsequently, the colorless viscous extract was collected by filtration using a sieve and transferred the contents of the beaker into a second container, followed by crushing the vegetable pieces with hand for further extraction. The extract was then filtered using a sieve so as to ensure complete removal of any vegetable bits.

III. MATERIALS

TABLE 1 CHEMICAL COMPOSITION OF SILICA FUME

Sr.No	Test Conducted	Results
1	Total sulphur content calculated as sulphuric anhydride (SO_3)	0.13
2	Iron oxide (Fe_2o_3)	1.27
3	Alumina (Al_2o_3)	0.81
4	Calcium oxide	<0.28
5	Magnesia (Mgo)	1.21
6	Chloride	0.028
7	PH	8.01
8	Loss on ignition	0.55
9	Moisture content	0.33
10	Silica content, (Sio_2)	93.96
11	Total alkalies as Na_20 equivalent	0.75

IV. EXPERIMENTAL WORK

TABLE 2 MIX PROPORTION 1 CUBIC METER CONCRETE FOR M50

VOLUME OF CONCRETE	WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	SP DOSAGE(KG)
1 m3	169	456.75	675	1187	2.74
	0.37	1	1.47	2.6	0.6

TABLE 3 MIX PROPORTION 1 CUBIC METER CONCRETE FOR M60

VOLUME OF CONCRETE	WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	SP DOSAGE(KG)
1 m3	169	482.85	666	1172	2.89
	0.35	1	1.38	2.42	0.6

V. COMPRESSIVE STRENGTH TEST

- Determination of compressive strength using by cube where size of cube specimen is 150×150×150 mm and this test was performed on a 2000 kN capacity compression testing machine.
- Load was applied without shock and increased continuously at a rate of approximately 140kg/cm2/min until the resistance of the specimen to the increasing load breaks down and no greater load was sustain. Maximum load was noted.
- The compressive strength of cube specimen is calculated using the following formula:

$$C = P/A$$

Where, C= Compressive Strength (N/mm2)
A=Area of cube (mm2)
P=Applied maximum load (KN)

TABLE 4 COMPRESSIVE STRENGTH M50

SR NO	OKRA EXTRACT	SILICA FUME	7 DAYS	28 DAYS
1	0	0	42.22	59.73
2	1:45	0	42.80	60.83
3	1:30	0	45.60	63.5
4	1:15	0	46.84	64.54

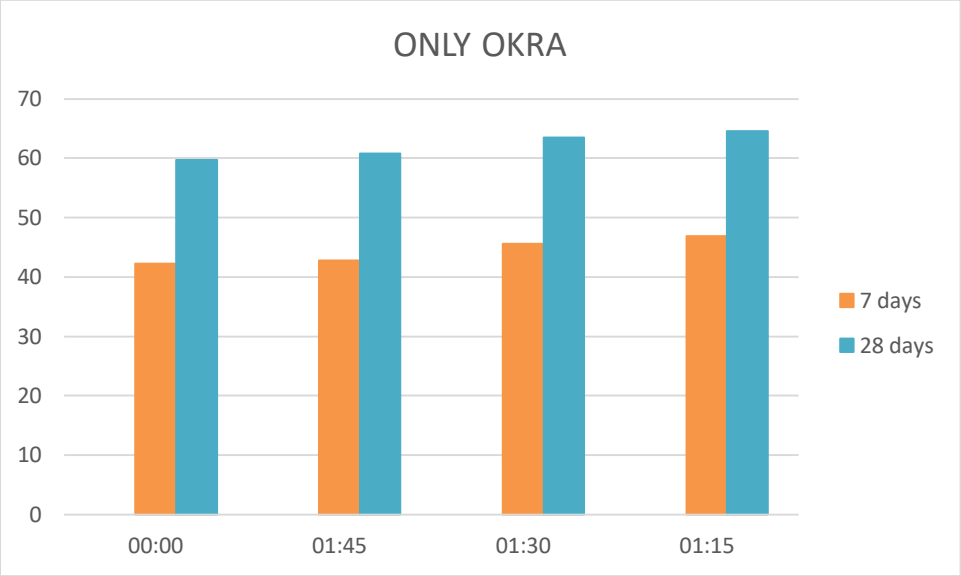

Figure 1 compressive strength m50

TABLE 5 COMPRESSIVE STRENGTH (WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	7 DAYS	28 DAYS
1	0	5	44.03	62.89
2	0	10	45.32	65.38
3	0	15	45.97	66.21

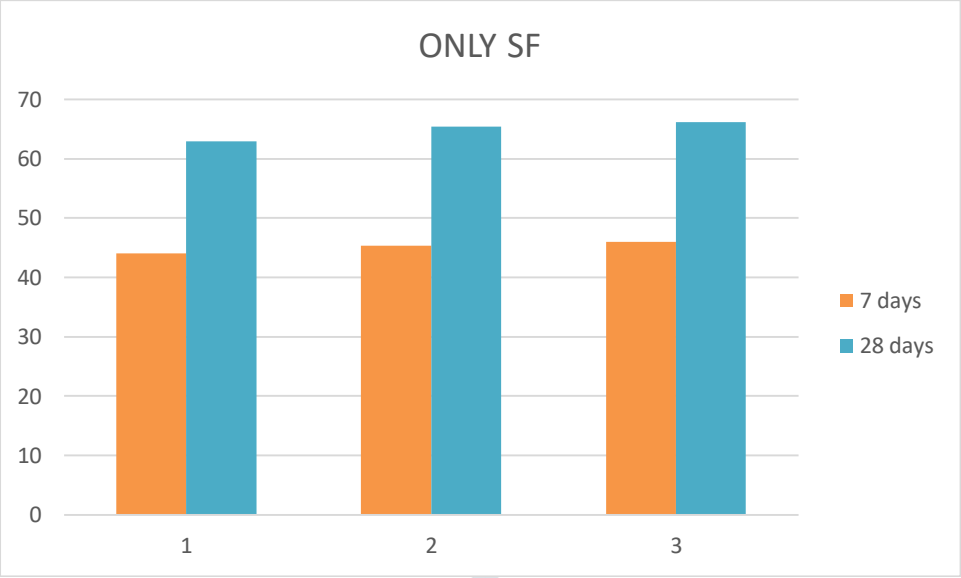

FIGURE 2 COMPRESSIVE STRENGTH (WITH SF

TABLE 6 COMPRESSIVE STRENGTH (1:45 WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	7 DAYS	28 DAYS
1	45	5	44.31	64.24
2	45	10	45.63	66.7
3	45	15	46.37	67.54

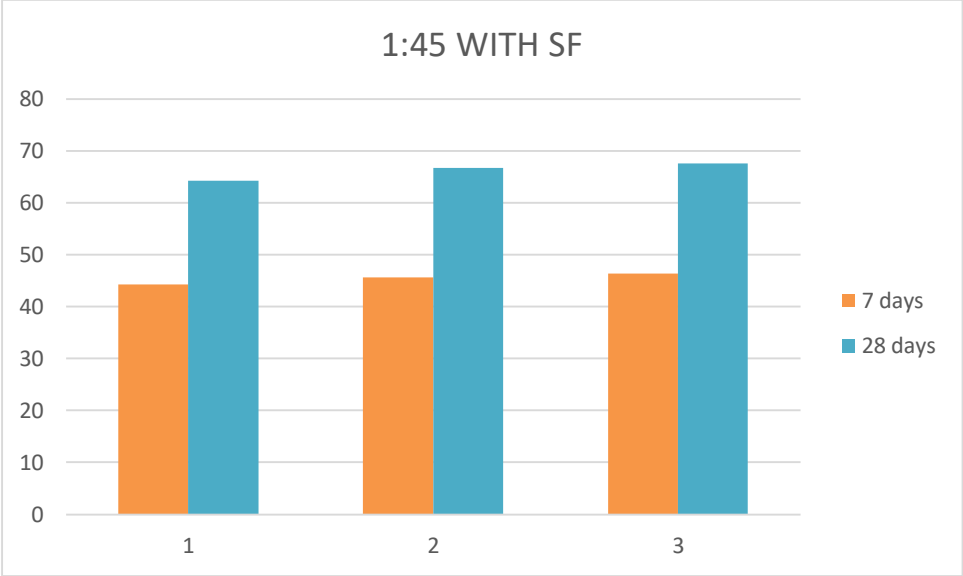

FIGURE 3 COMPRESSIVE STRENGTH (1:45 WITH SF)

TABLE 7 COMPRESSIVE STRENGTH (1:30 WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	7 DAYS	28 DAYS
1	30	5	45.52	64.65
2	30	10	46.85	67.04
3	30	15	47.57	67.79

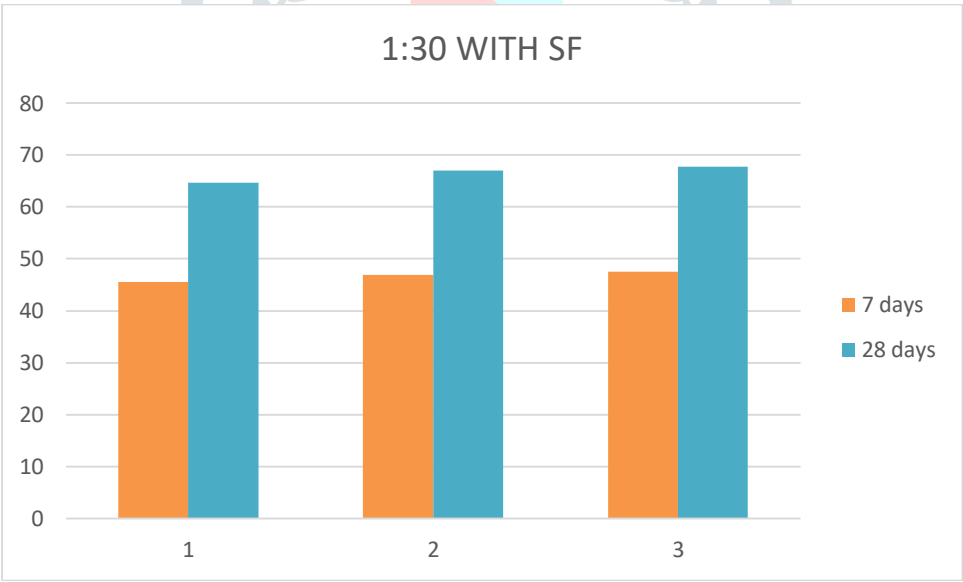

FIGURE 4 COMPRESSIVE STRENGTH (1:30 WITH SF)

TABLE 8 COMPRESSIVE STRENGTH (1:15 WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	7 DAYS	28 DAYS
1	15	5	45.93	64.72
2	15	10	46.95	67.16
3	15	15	47.89	68.22

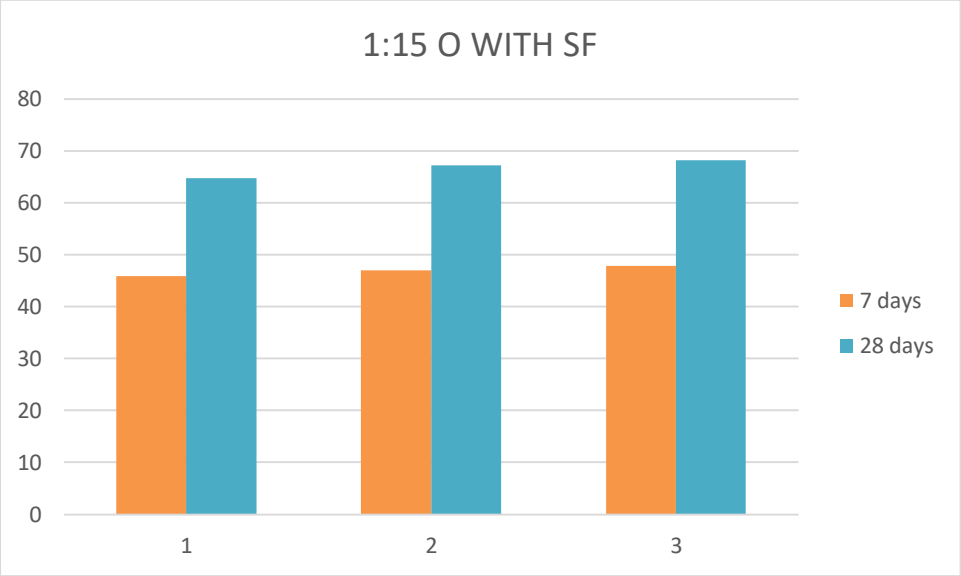

FIGURE 5 COMPRESSIVE STRENGTH (1:30 WITH SF)

V. DURABILITY TEST

Durability is the ability to last a long time without significant deterioration. A durable material helps the environment by conserving resources and reducing wastes and the environmental impacts of repair and replacement. The production oreplacement building materials depletes natural resources and can produce air and water pollution.Concrete resists weathering action, chemical attack, and abrasion while maintaining its desired engineering properties. Different concretes require different degrees of durability depending on the exposure environment and the properties desired. Concrete ingredients, their proportioning, interactions between them, placing and curing practices, and the service environment determine the ultimate durability and life of the concrete. Concrete is susceptible to acid attack because of its alkaline nature. During acid attack on the cement paste break down. Since concrete is an alkaline substance many of its components readily react with acid. In most cases the reaction between the attacking acid and calcium compound forms calcium salts, which can be soluble in water. Acid attack weakens the concrete structurally and reduces its durability and service life. The acids most commonly attacked by concrete are carbonic acid, humic acid, and sulphuric acid. The bureau of Indian standard specified the maximum chloride content in cement as 5 percent. But it is now increased the allowable chloride content in cement to 0.1 percent. The cubes were cast of size 150x150x150 mm and kept at least 90 percent relative humidity for 24 hours. After 24 hours the cubes were unmoulded and immersed in fresh water for 28 days. After 28 day curing cubes were immersed in 5% concentrated HCL and H2SO4 for 56 days. After 56 days cubes were tested for compressive strength test.The durability of cube specimen is calculated using the following formula:

$$\sigma = P/A$$

Where P = failure load

A = cross sectional area in mm

TABLE 9 DURABILITY (OKRA EXTRACT)

SR NO	OKRA EXTRACT	SILICA FUME	HCL	H_2S0_4
1	0	0	54.93	49.15
2	1:45	0	56.50	50.91
3	1:30	0	58.11	52.07
4	1:15	0	60.07	53.43

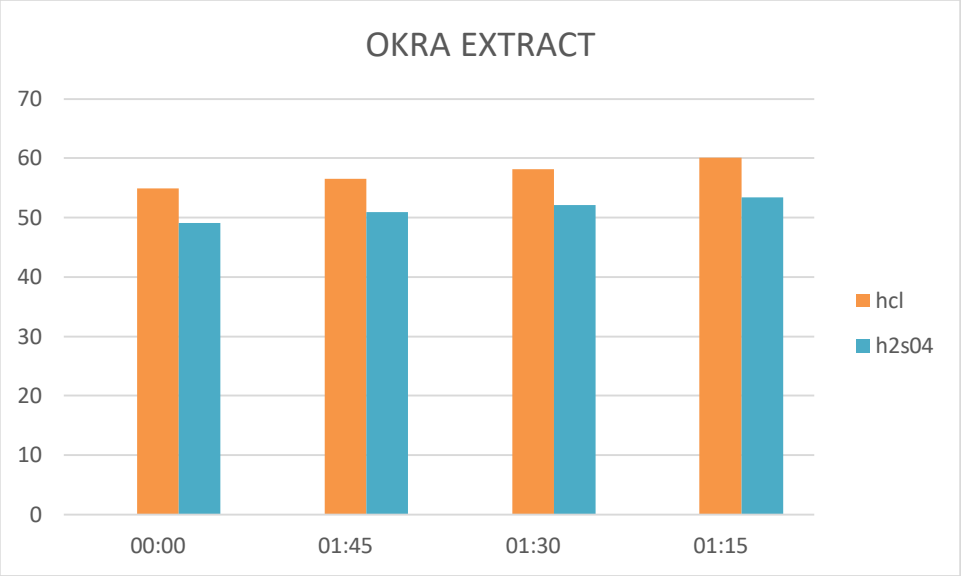

FIGURE 6 DURABILITY (OKRA EXTRACT)

TABLE 10 DURABILITY (ONLY SF)

SR NO	OKRA EXTRACT	SILICA FUME	HCL	H_2S0_4
1	0	5	59.65	52.28
2	0	10	61.23	54.40
3	0	15	62.36	55.33

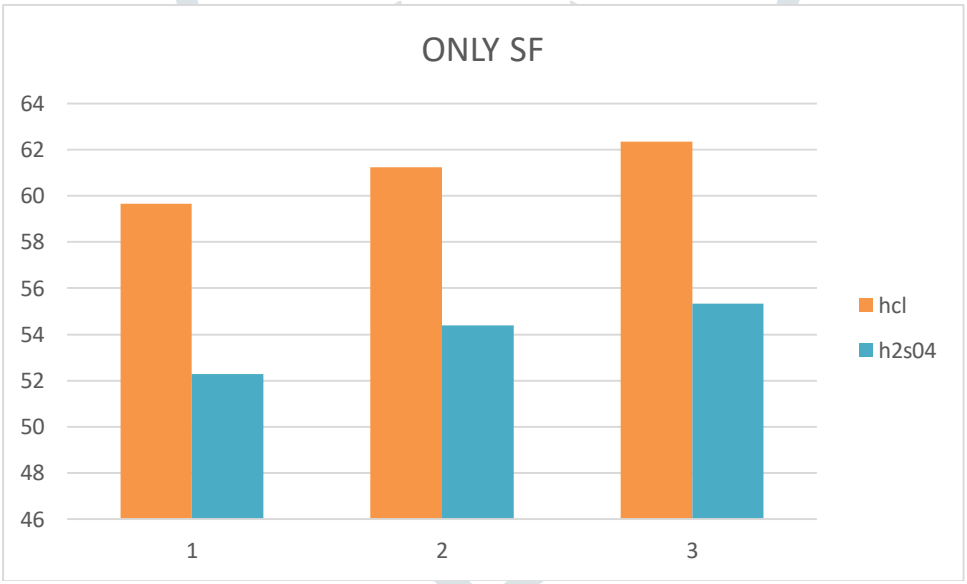

FIGURE 7 DUARBILITY (ONLY SF)

TABLE 11 DURABILITY (1:45 WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	HCL	H2S04
1	1:45	5	60.27	54.13
2	1:45	10	62.39	56.06
3	1:45	15	63.65	57.28

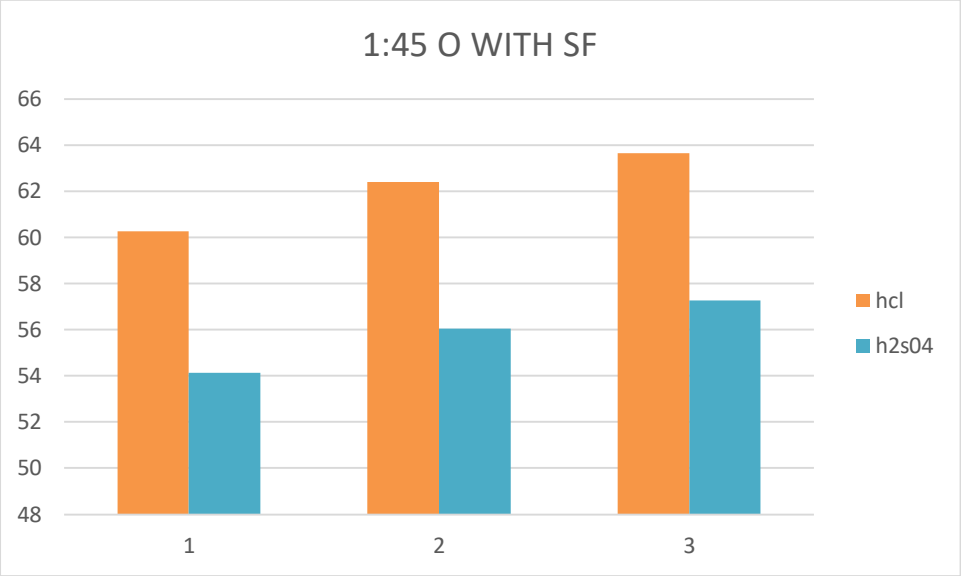

FIGURE 8 DURABILITY (1:45 WITH SF)

TABLE 12 DURABILITY (1:30 WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	HCL	H2S04
1	1:30	5	60.14	54.13
2	1:30	10	62.17	56.06
3	1:30	15	62.67	57.28

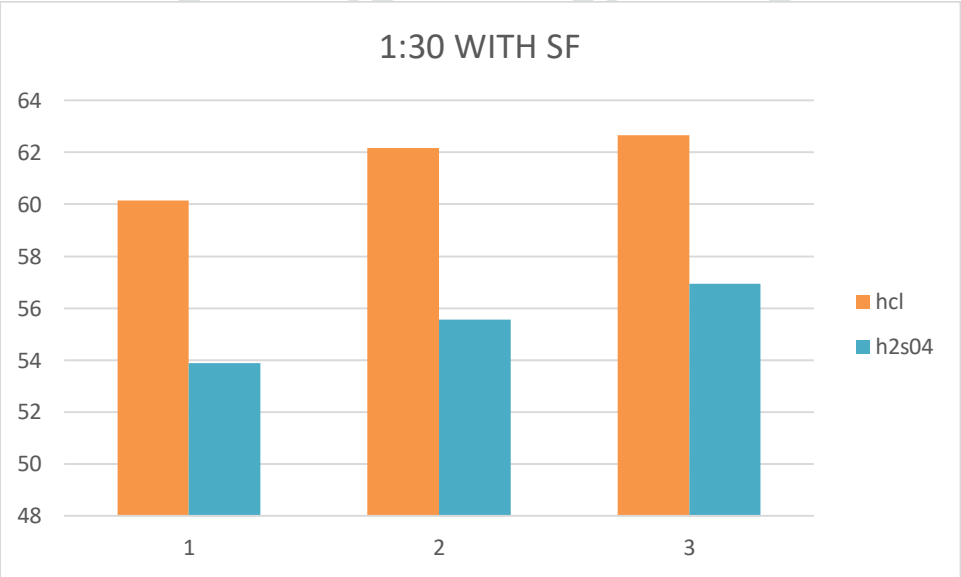

FIGURE 9 DURABILITY (1:30 WITH SF)

TABLE 13 DURABILITY (1:15 WITH SF)

SR NO	OKRA EXTRACT	SILICA FUME	HCL	H2S04
1	1:15	5	59.66	53.36
2	1:15	10	61.92	55.66
3	1:15	15	62.27	55.98

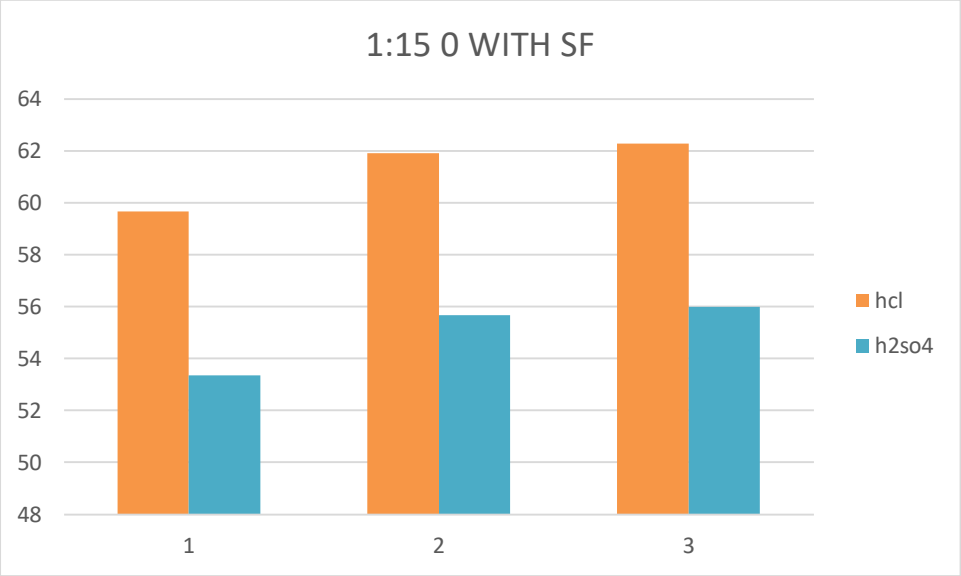

FIGURE 10 DUARBILITY (1:15 WITH SF)

VI .CONCLUSION

After the detailed experimental study carried out following remarkable concluding points have been observed

- FTIR investigation indicates the pectin a major compound present in okra extract
- The chemical composition showed that okra extract having more calcium than silica
- The PH and hardness of okra extract were 6.35 and 657.79
- The compressive strength of concrete prepared using okra extract without silica fume increases constantly as ratio increases.
- By using only okra extract in the ratio of 1:45, 1:30, 1:15 strength increases in the range of 1.37 to 10.94 % respectively for 7 days and 1.84 to 8.05 % respectively for 28 days.
- Replacement of okra extract should be limited to 1:45.
- Addition of okra extract decreased workability.
- Replacement of silica fume with cement improves the compressive strength
- 9 In normal concrete the improvement observed in the range of 5.29 to 10.84% at 15% replacement of silica fume
- The compressive strength of concrete prepared using okra extract with silica fume increases constantly as ratio increases.
- By using okra extract 1:45 with 5, 10, 15% silica fume shows the compressive strength in the range of 4.95 to 9.82% for 7 days and 7.55 to 13.07% for 28 days respectively
- By using okra extract 1:30 with 5, 10, 15% silica fume shows the compressive strength in the range of 7.81 to 12.67% for 7 days and 8.23 to 13.49% for 28 days respectively
- By using okra extract 1:15 with 5, 10, 15% silica fume shows the compressive strength in the range of 8.78 to 13.42% for 7 days and 8.35 to 14.214% for 28 days respectively
- If okra extract and silica fume used in combination optimum replacement is 1:15 and with 15 % silica fume respectively.
- Durability test showed that reduction in strength for concrete but can be controlled using silica fume.

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