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An Experimental Study on Strength & Durability Properties of Blended Concrete by Partial Replacement of Cement by Silica Fume & Flyash and Coarse Aggregate with Steel Hook Fibres

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ABSTRACT: The cost of construction materials is currently so high that only governments, corporate organizations and wealthy individuals can afford to do meaningful constructions. Unfortunately, production of cement involves emission of large amount of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and global warming, hence it is inevitable either to search for another material or partly replace it by some other material.

The utilization of fine Pozzolonic materials in high-strength concrete (HSC) like silica fume and fly ash leads to reduction in size of the crystalline compounds, particularly, calcium hydroxide. Consequently, there is a reduction of the thickness of the interfacial transition zone in high-strength concrete. Applications of mineral admixtures such as silica fume (SF), fly ash (FA) in concrete are effective and easy to future increase in the strength and make durable for high strength concrete. The addition of admixtures to the concrete mixture increases the strength by pozzolonic action and filling the small voids and that are created between cement particles.

In the present study, the different admixtures were used to study their individual and combined effects on the resistance of concrete in addition to their effects on workability, durability and compressive strength by the replacement of admixtures by 10%, 15% of silica fume &10%, 20% and 30% of fly ash by the weight of cement with a constant amount of 0.5% steel hook fibres are added by volume of concrete, throughout the study.

KEYWORDS: Silica fume, Fly ash, Steel hook fibres, Compressive Strength, Split tensile Strength, Flexural strength, ultra sonic pulse velocity, durability.

I.INTRODUCTION

The cost of construction materials is currently so high that only governments, corporate organizations and wealthy individuals can afford to do meaningful constructions. Unfortunately, production of cement involves emission of large amount of carbon-dioxide gas into the atmosphere, a major contributor for green house effect and global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. The use of supplementary cementations materials or mineral admixtures such as silica fume as fly ash in concrete fits very well with sustainable development. The volume of silica fume and fly ash in concrete mixtures contain lower quantities of cement.



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As our aim is to develop high strength concrete which does concern on the strength of concrete, it also having many other aspects to be fulfilled like less porosity, capillary absorption, durability. Also now a day's one of the great applications in various structural fields are high strength fibre reinforced concrete, which is getting popularity because of its positive effect on various properties of concrete.

II. LITERATURE REVIEW

1. P.S Song, S.Hwang examined on mechanical properties of high strength steel fibre reinforced concrete. The marked brittleness with low tensile strength and strain capacities of high-strength concrete (HSC) can be overcome by the addition of steel fibres.

2. Vahid Afroughsabet, Togay Ozbakkaloglu examined on Mechanical and durability properties of high-strength concrete containing steel and polypropylene fibres. The effect of the addition of steel and polypropylene fibres on the mechanical and some durability properties of high-strength concrete (HSC).

3. A.Annadurai1, A. Ravichandran examined on development of mix design for high strength Concrete with Admixtures. The results of mix design developed for high strength concrete with silica fume and High range water reducing admixture (HRWR). It involves the process of determining experimentally the most suitable concrete mixes in order to achieve the targeted mean strength.

4. B. Muhit1, S. S. Ahmed2, M. M. Amin1 and M. T. Raihan examined on industrial by products such as Silica Fume (SF) and Fly Ash (FA) can be utilized to enhance the strength and water permeability characteristics of High Performance Concrete (HPC).

5. Er. Magudeaswaran, Dr. Eswaramoorthi examined on durability characteristics of High Performance Concrete. The conventional concrete has lost its usage in modern days as it does not serve the present needs. Hence to improve the workability, durability and the ultimate strength of the concrete, high performance concrete (HPC) with super plasticizers and pozzolans are used.

6. P. D. Kumbhar1 and P. B. Murnal examined on new mix design method for high performance concrete under tropical conditions. High performance concrete (HPC) has become more popular in recent years. However, mix proportioning of HPC is a more critical process than normal strength concrete (NSC).

7. West Nippon Expressway Company Limited examined on development of high-strength fibre reinforced concrete for highly durable bridge structures. As one way to construct the highly durable and long lifetime concrete structures, it is considered that steel rebars and PC tendons are reduced in concrete structures. This paper describes development of high-strength fibre reinforced concrete (HSFRC), which is developed mainly to increase shear strength of the concrete.

8. Saiyad Waquar Husain examined on strength and behaviour of steel fibre reinforced concrete with fly ash for m30 grade using Steel fibre and fly ash are common additives that can improve concrete performance. The aim of study was to measure compressive strengths of concrete of M30 grade with different steel fibre percentages and fly ash percentages. Concrete specimens with fibre contents of 0.5, 1.0 and 1.5 % by weight were tested.

9. A. A. Elsayed examined on Influence of Silica Fume, Fly Ash, Super Pozz and High Slag Cement on Water Permeability and Strength of Concrete with Increase in the replacement ratios for other mineral admixtures than ordinary Portland cement concrete. The main in this study, effects of mineral admixtures on water permeability and compressive strength of concretes containing silica fume (SF), fly ash (FA) and super pozz (SP) were experimentally investigated.

10. K.R.Venkatesan, P.N.Raghunath, K.Suguna examined on Flexural Behaviour of High Strength Steel fibre Reinforced Concrete Beams. The results of experimental study conducted to examine the effectiveness of steel fibre in



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enhancing flexural capacity of high strength concrete (HSC) beams. In this study a total of four beams of 3 m length and 150mm x 250mm in cross-section were cast and tested in the laboratory.

11. Wasan Ismail Khalil, IkbalNaeemGorgis and ZeinabRaad Mahdi examined on behaviour of high performance fibre reinforced concrete columns by conducting an experimental program. In this research to investigate the behaviour of square short high performance concrete columns with and without steel fibre under concentric compression loading.

12. N. Ganesan, P.V. Indira and Ruby Abraham examined on steel fibre reinforced high performance concrete beam-column joints subjected to cyclic loading. The experimental results of ten steel fibre reinforced high performance concrete (SFRHPC) exterior beam-column joints under cyclic loading. The M60 grade concrete used was designed by using a modified ACI method suggested by Aïtcin. Volume fraction of the fibres used in this study varied from 0 to 1% with an increment of 0.25%.

III. EXPERIMENTAL INVESTIGATION

The objective of the present work is to develop concrete with good strength, less porous, less capillarity so that durability will be reached. For this purpose it requires the use of different pozzolonic materials like Fly ash and silica fume along with fibre. The physical and chemical properties of cement, fine aggregates, coarse aggregates and water used in this investigation are analyzed based on standard experimental procedure laid down in standard codes like Indian standard code, ASTMC, and Bureau of Indian standard codes. Strength tests, ultrasonic pulse velocity and durability tests are conducted in this project.

MATERIALS:

The materials used in present investigation include;

- 1. Cement-Ordinary Portland Cement (OPC)
- 2. Mineral Admixtures-
- a. Silica Fume and
- b. Fly-Ash
- 3. Fine aggregates
- 4. Coarse aggregates
- 5. Steel hook fibres as admixture and
- 6. Water

CEMENT:

Ordinary Portland cement of 53 grades was selected for the experimental investigation. The compressive strength characteristics of cement were tested as per IS: 4031-1988 and IS: 12269-1987(9). The cement used in present study was Zuari cement. The experiments such as standard consistency, initial setting time, final setting time and specific gravity of cement are conducted on ordinary Portland cement.



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S.No	Characteristic of cement	Value	Code specifications (IS 4031-1988)
1	Fineness of cement	94.76%	-
2	Normal consistency	33%	Not specified
3	Initial setting Time	40 minutes	>30
4	Final setting time	350 minutes	<600
5	Specific gravity	3.14	-

TABLE 1.PHYSICAL PROPERTIES OF OPC

AGGREGATE: It should be passed through IS Sieve. As fine aggregate (F.A) natural sand from river is used conforming to IS383-1970. Which comes under zone II. As a course aggregate hard granite chips passing 20mm down where used conforming to IS383-1970. Various tests such as specific gravity water absorption and sieve analysis have been conducted on (F.A) and (C.A) to know the good quality and grading.

TABLE 2. PROPERTIES OF FINE AGGREGATESPROPERTIES

S.No	Properties	Results
1.	Specific gravity	2.583
2.	Bulking of sand	4
3.	particle size	0.15 to
4	Water absorption	1
5	Bulk Density of	1460
6	Fineness modulus	2.8

TABLE 3.COARSE AGGREGATE

S. No	Properties	Unit	Results				
1.	Specific	-	2.68				
2.	Particle size	mm	6.35 to 6.4				
3	Fineness	-	6.26				
4	Water	%	0.5				
5	Bulk	kg/m ³	1469.8				
6	Elongation	%	20.49				
7	Flakiness	%	13.19				

SILICA FUME:

Silica fume also known as micro silica, is an amorphous polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150mm.

FLYASH:

Flyash or flue ash, also known as pulverised fuel ash in the united kindom, is a coal combustion product that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boilers combustion chamber is called bottom ash.



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STEEL HOOK FIBERS:

Stainless steel fibers are manufactured fibers composed of stainless steel. Composition may include carbon(C), silicon(Si), manganese(Mn), phosphorus(P), sulphur(S), and other elements. The properties are oxidation withstanding, electrical conductivity & thermal resistance.

IV .RESULTS AND ANALYSIS

TABLE 4.COMPRESSIVE STRENGTH COMPARISION FOR ALL PROPORTIONS OF CONCRETE WITH0.5% STEEL HOOK FIBRES ASADMIXTURE

S.	SAMDI E	AVERAGE COMPRESSIVE STRENGTH										
NO	SAMPLE	3 days	7 days	28 days	56 days	90 days						
1	Controlled mix	27	44	67.7	75.5	77.54						
2	10%SF+10%FA+0.5%SHF	36.6	49.4	74	79.03	80.21						
3	10%SF+20%FA+0.5%SHF	40.9	50.17	80	82.5	84.4						
4	10%SF+30%FA+0.5%SHF	39	49.1	75.33	81.03	82						
5	15%SF+10%FA+0.5%SHF	38	48.48	73.23	79.51	81.5						
6	15%SF+20%FA+0.5%SHF	35.2	48	73.67	78.21	79.66						
7	15%SF+30%FA+0.5%SHF	34.52	46.23	71.55	74.56	78.00						



Fig 1 Compressive Strength Comparison of All Proportions of Concrete

SPLIT TENSILE TEST RESULTS

When silica fume percentage increases from 0% to 20%, the normal consistency is increases about 40%. Increase in split tensile strength beyond 10% silica fume replacement was almost unsatisfactory. In this study M60 grade concrete and it was found that maximum split tensile strength of 5.5 N/mm2 was obtained for 10% silica fume, 30% fly ash and 0.5% steel hook fibres.



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TABLE 5. SPLIT TENSILE STRENGTH RESULTS OF CONCRETE MADE WITH DIFFERENT REPLACEMENT LEVELS OF SILICA FUME AND FLY ASH

Days	Cases	Average split tensile strength (N/mm2)
	Controlled mix	3.5
	10% SF+10% FA+ 0.5% steel fibres	4.8
28 days	10% SF+20% FA+ 0.5% steel fibres	5.5
	10% SF+30% FA+ 0.5% steel fibres	4.9
	15% SF+10% FA+ 0.5% steel fibres	4.5
	15% SF+20% FA+ 0.5% steel fibres	4.4
	15% SF+30% FA+ 0.5% steel fibres	3.6







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From above graphs it has been seen that, the comparison of split tensile strength results of concrete for various replacements of silica fume and fly ash with 0.5% steel hook fibres as admixture. At 10% silica fume and 20% fly ash gives maximum 28 days split strength as 5.5N/mm2.

Flexural Strength:

The steel mould of size 500x100x100 is well tighten and oiled thoroughly. They were allowed for curing in a tank After 28 days curing, prismatic specimens are placed on flexural testing machine having a maximum of 100 KN and a constant rate of loading of 40 kg/m² per minute is applied on the test specimen by placing the specimen in such a way that the two point loading should be placed at a distance of 13.3 cm from both the ends. Ultimate load at which the prismatic specimen fails is noted down from dial gauge reading.

TABLE 6. FLEXURAL STRENGTH OF CONCRETE WITH DIFFERENT PERCENTAGE OF SILICA FUME AND FLY ASH

S.No	Age	Sample	Load (KN)	Average Modulus of rupture (MPa)				
1	28	Controlled mix	18.75	14.16				
2	28	S10F10	20.8	15.8				
3	28	S10F20	26.00	19.50				
4	28	S10F30	20.8	15.8				
5	28	S15F10	25.95	19.49				
6	28	S15F20	20.70	15.55				
7	28	S15F30	20.40	15				

S= % of silica fume, F= % of fly ash



Fig 3: Flexural strength at 28 days for various percentages of Silica Fume and Fly Ash

From above graphs it has been seen that, the comparison of flexural strength results of concrete for various replacements of silica fume and fly ash with 0.5% steel hook fibres as admixture. At 10% silica fume and 20% fly ash gives maximum 28 days split strength as 19.50N/mm2, next higher value occurs at 15% silica fume and 10% fly ash with 0.5% steel hook fibres as 19.49 N/mm².



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S.No	Samples	Length (mm)	path time (µ-sec)	Average pulse velocity (km/sec)	quality of concrete
1	Controlled mix	150	34.63	4.33	Good
2	S10F10	150	35.80	4.19	Good
3	S10F20	150	35	4.28	Good
4	S10F30	150	38.7	3.87	Good
5	S15F10	150	39.7	3.77	Good
6	S15F20	150	35.8	4.18	Good
7	S15F30	150	36.33	4.15	Good

TABLE 7: RESULTS OF ULTRA-SONIC PULSE VELOCITY TEST

S= % of silica fume

F=% of fly ash

From above table it is observed that, the average pulse velocity for all proportions of concrete are in between 3.5 km/sec to 4.5 km/sec. As per BS 12504-4, 2004 code it is concluded that all the samples are graded as good quality concrete.

6.7 DURABILITY TEST RESULTS

TABLE 6.6 WATER ABSORPTON TEST FOR DIFFERENT PROPRTIONS OF CONCRETE

S. No	Sample	Wet weight (kgs)	Dry weight (kgs)	Water absorption in %
1	CC	8.49	8.40	1.07
2	S10F10	8.52	8.43	1.06
3	S10F20	8.53	8.42	1.30
4	S10F30	8.39	8.33	0.72
5	S15F10	8.42	8.32	1.20
6	S15F20	8.40	8.39	0.11
7	S15F30	8.01	8.04	0.37



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From above table it is observed that, the percentage water absorption for different proportions of concrete varies with the silica fume and fly ash replacement. With increase in silica fume and fly ash replacement to cement shows decreased percentage of water absorption because of their fine particle size. At 10% and 15% replacement of silica fume with 30% fly ash gives low water absorption as 0.37%.

TABLE 6.7 PERMEABILITY OF CHLORIDE IN CONCRETE FOR EVERY 30 MINUTES INTERVEL UP TO 6 HOURS BY USING RCPT APPARATUS FOR DIFFERENT DOSAGES OF SILICA FUME AND FLY ASH AS CEMENT REPLACEMENT AND STEEL FIBERS AS ADMIXTURE:

S.N O	SAMPLE	I 0	I ₃ 0	I ₆ 0	I9 0	I ₁₂ 0	I ₁₅ 0	I ₁₈ 0	I ₂₁ 0	I ₂₄ 0	I ₂₇ 0	I ₃₀ 0	I ₃₃ 0	I ₃₆ 0	I cumulativ e in mA	I _{average} in coulomb s	Penetrabilit y of chloride
1	CC	8	8	8	8	9	9	9	9	10	10	11	12	12	2.30	2070	М
2	10%SF+10%FA+0.5%S HF	8	1 0	9	1 0	12	11	12	13	17	20	19	17	18	3.26	2934	М
3	10%SF+20%FA+0.5%S HF	0	0	1	2	2	4	6	6	8	10	11	14	16	1.44	1296	L
4	10%SF+30%FA+0.5%S HF	0	1	1	1	1	1	2	2	8	8	8	10	10	0.96	8624	VL
5	15%SF+10%FA+0.5%S HF	8	8	9	9	9	9	10	10	12	12	17	17	19	2.73	2457	М
6	15%SF+20%FA+0.5%S HF	0	0	0	1	1	5	5	5	6	10		11	11	1.23	1107	L
7	15%SF+30%FA+0.5%S HF	0	0	0	1	1	2	2	2	4	4	4	6	6	0.58	522	VL

SF= % of silica fume SHF=Steel hook Fibres FA = % of fly ash



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The Rapid Chloride Permeability Test results are presented in the above table 6.5 for different dosages of 10% and 15% of silica fume and 10%, 20% 30% of fly replacement to cement with a constant proportion of 0.5% steel hook fibers are added to the concrete. The results were noted for every 30min up to 6hours from RCPT apparatus by summing up the readings the calculations are done by using Table 5.7 presents the chloride ion penetrability based on charge passed as per ASTM C 1202 is decided.

The effects on different dosages of silica fume, fly ash and steel fibers, the test results of chloride permeability through Rapid Chloride Permeability Test are presented in the table 6.5.2 for different proportions of concrete. The concrete specimen tested by RCPT according to the results noted for combinations of OPC with 10% silica fume and 30% fly ash as replacement to cement and addition of steel fibers at the 0.5% showed the very low permeability to chloride ion permeability and at 15% silica fume and 30% fly ash as replacement to cement and addition of steel fibers at the 0.5% also showed very low permeability to chloride ion.

From above test results it is observed that, with increase in percentage of silica fume and fly ash replacement to cement shows higher resistance to chloride ion permeability.

V. CONCLUSION

Based on the results obtained from the present investigation the following conclusions were made;

1. By the addition of steel hook fibres in concrete results in growth in compressive strength and makes concrete into ductile.

2. In split tensile and flexural tests, we notices that crack width reduced because of the presence of steel fibers whilst as compared with conventional specimen.

3. When the cement is changed with 10% silica fume and 20% fly ash offers the greatest compressive strength, break up tensile strength and flexural strength.

4. At 10% silica fume and 20% fly ash substitute to cement, compressive strength have been accelerated up to 80% when in comparison with conventional concrete for 28 days.

5. At 10% silica fume and 20% fly ash replacement to cement, split tensile strength had been increased up to 5.5% whilst as compared with traditional concrete for 28 days.

6. At 10% silica fume and 20% fly ash alternative to cement, flexural strength had been accelerated as much as 19.50% when in comparison with conventional concrete for 28 days

7. The addition of silica fume and fly ash as substitute to cement, its regular consistency and initial setting time increases with growth in percentage and final setting time decreases with boom in percentage.

8. The use of mineral admixtures in concrete reasons big reduction in the quantity of large pores at every age and thereby reduces the permeability of concrete mixes due to its high fineness and formation of C-S-H gel.

REFERENCES

- 1. A.M. Shende, A.M. Pande, M. Gulfam Pathan(sep 2012), Experimental Study on Steel Fiber Reinforced Concrete for M-40 Grade, International Refereed Journal of Engineering and Science (IRJES).
- 2. P. R. Wankhede, V. A. Fulari(july 2014) ,Effect of Fly ASH on Properties of Concrete, International Journal of Emerging Technology and Advanced Engineering(IJETAE) ,ISSN 2250-2459, ISO 9001:2008 Certified Journal.
- 3. Ushida, K., Nasir, S., Uehara, T., and Umehara, H. (2004). "Effects of Fiber Shapes and Contents on Steel Fiber Reinforcement in High-Strength Concrete."
- 4. Goplakrishnan, S., Rajamane, N.P., Neelamegam, M., Peter, J.A. and Dattatreya, J.K (2001), "Effect of Partial Replacement of Cement with Fly ash on the Strength and Durability of HPC"
- 5. M.S Shetty, "Concrete Technology". year 2008.



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- 6. M.L.Gambhir, "Concrete Manual", Dhanpat Rai Publications.
- M.L.Gambhir (2009), "Concrete Technology. Theory and Practice", Mc Graw Hill Publications
- 7. P.K. Mehata: (Concrete International 17/97), "Durability Critical issues for the future".
- 8. P.K.mehta (2005): "High-Performance, High volume Fly ash Concrete for sustainable Development".
- 9. Singh, S. P. Mohammadi, Y. and Kaushik, S. K. (2005), Flexural Fatigue Analysis of Steel Fibrous Concrete Containing Mixed Fibres.
- 10. Cusson D. and Paultre P. 1995. Stress-Strain Modelfor Confined High-Strength Concrete.
- 11. Li B., Park R. and Tanaka H. 1994. Strength and Ductility of Reinforced Concrete Members and Frames Constructed Using HSC.
- 12. Cusson D. and Paultre P. 1994. High-Strength Concrete Columns Confined by Rectangular Ties.
- 13. Razvi S. and Saaticioglu M. 1994. Strength and deformability of confined high strength concrete columns.
- 14. Pessiki S. and Pieroni A. 1997. Axial Load Behavior of Large Scale Spirally Reinforced High Strength Concrete Columns