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RESEARCH ARTICLE

INVESTIGATIONAL STUDY ON PARTIAL REPLACEMENT OF METAKAOLINE IN CEMENT CONCRETE

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ABSTRACT

The term high-strength concrete (HSC) is generally used for concrete with compressive strength higher than 41MPa. ACI Committee had defined High Strength Concrete (HSC) is the concrete that can attain specified compressive strength for design of at least 41MPa, or more. With the development of high grade cement and availability of proper mineral admixtures and chemical admixtures, it has become quite common to adopt concrete with compressive strength of 60MPa and above. Development of high strength concrete has made it possible to build taller and long span structures. But it has been proved that the comparatively higher compressive strength of High Strength Concrete is an attractive profit from engineering characteristics and economic point of view whereas, the strength behaves against the ductility of concrete by welcoming brittleness pronouncedly. To improve the ductility of High Strength Concrete, a strategy is to introduce steel in High Strength Concrete which results in development of a material with reasonable tensile strength and greater toughness which prevents the initiation and propagation of cracks. Plain concrete and High Strength Concrete possess a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are present in the concrete and its poor tensile strength is due to the propagation of such micro cracks. In plain concrete, structural cracks (micro-cracks) develop even before loading, due to drying shrinkage or other causes of volume change. The width of these initial cracks is few microns, but their other dimensions may be of higher magnitude. When loaded, the micro cracks propagate and open up, and additional cracks form in places of minor defects. The development of such micro cracks is the main cause of inelastic deformations in concrete. The addition of small closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as Fiber Reinforced Concrete.

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INTRODUCTION

The term Fiber Reinforced Concrete (F.R.C) is defined by ACI Committee 544 as a concrete made of hydraulic cements containing fine and coarse aggregates and discontinuous discrete fibers. Inherently concrete is brittle under tensile loading. Mechanical properties of concrete can be improved by reinforcement with randomly oriented short discrete fibers, which prevent and control initiation, propagation and coalescence of cracks. Fiber Reinforcement is commonly used to provide toughness and ductility to brittle cementitious matrices.

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Reinforcement of concrete with a single type of fiber may improve the desired properties to a limited level. Fiber Reinforced Concrete is the type of concrete which contains Fibrous materials which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, polypropylene fibers glass fibers, natural fibers. Within these different fibers, that character of fiber reinforced concrete changes with varying concretes, fiber materials, geometrics, distribution, orientation and densities. In Fiber Reinforced Concrete, fibers can be effective in arresting cracks at both macro and micro levels.

High Strength Concrete

P. Muthupriya *et al.*, (2011) studied the behavior of short columns produced from High Performance Concrete (HPC). In the investigation HPC grade M60 was manufactured with usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixtures such as silica fume and fly ash at various replacement levels and the super plasticizer(1.5% by weight of cement). The water binder ratio adopted was 0.3. Specimens such as cubes, cylinders and prisms were casted and tested for various mixes viz., seven mixes M1 to M7 are casted with 0%, 5%, 7.5% and 10% replacement of silica fume to cement and another replacement of fly ash to study the mechanical properties such as compressive strength, split tensile strength and flexural strength at different ages of concrete 3,7,28,56 and 90 days. The result showed that the optimum replacement of silica fume is at 7.5%. B.B.Patil and P.D .Kumbhar (2012) studied the strength and durability properties of High Performance Concrete incorporating High Reactivity Metakaoline. In this investigation HPC grade M60 was manufactured with usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixture Metakaoline at various replacement levels and the super plasticizer (0.73% by weight of cement). The water binder ratio adopted was 0.31. Cube specimens were casted and tested for various mixes viz., 6 mixes were casted with 0%,5%,7.5%,10%,12.5% and 15% replacement of Metakaoline to cement to study the compressive strength of concrete at 28 days. The result showed that the durability & strength of concrete are increased at an optimum replacement of Metakaoline at 7.5%.

High Strength Concrete with Fibers

A.Ravichandran *et al.*, [2009] studied the Strength Modeling of High-Strength Concrete with Hybrid Fiber Reinforcement. In their investigation High Strength Concrete (HSC) OF 60 Mpa containing hybrid fibers, combination of Steel and Polyoefin fibers, at different volume fraction of 0.5%,1.0%,1.5% and 2% were compared in terms of compressive, splitting tensile strength and flexural properties with HSC containing no fibers. The test results showed that the fibers when used in hybrid form could result in enhanced flexural toughness compared to steel fiber reinforced concrete [HSFRC]. The compressive strength of the fiber reinforced concrete reached maximum at 1.5% volume fractions and the splitting tensile strength and modulus of rupture improved with increasing volume fraction. S. Eswari *et al.*, (2008) have studied on Ductility Performance of Hybrid Fiber Reinforced Concrete. The study presented a study on the ductility performance of hybrid fiber reinforced concrete. The influence of fibre content on the ductility performance of hybrid fibre reinforced concrete specimens having different fiber volume fractions was investigated. The parameters of investigation included modulus of rupture, ultimate load, service load, ultimate and service load deflection, crack width, energy ductility and deflection ductility. The specimens incorporated 0.0 to 2.0% volume fraction of polyolefin and steel fibers in different proportions. The ductility performance of hybrid fiber reinforced concrete specimens was compared with that of plain concrete. The test results show that addition of 2.0% by volume of hybrid fibers improves the ductility performance appreciably. Dr. Salahaldein Alsadey 2012 studied the Influence of Super plasticizer on strength of concrete. In this study it is focused on the effects of super plasticizer admixture on properties of concrete. Concrete mixes with SP dosages of 600,800,1000 and 1200ml/100 kg of cement i.e 0.6,0.8,1.0,1.2% respectively were prepared of grade M30. After casting, normal curing was carried out on the concrete samples. Compressive Strength was determined after 28 days of curing. The Compressive strength was improved by dosage 1.0% of SP by 55N/mm2 for M30 grade concrete. From the above graph, it is observed that the compressive

EXPERIMENTAL RESULTS AND DISCUSSION

Table . Test Results of Mechanical Properties of High Strength Concrete with the addition of multi-mineral admixtures at 28 days

S. No	Mix Designation	Mix Proportion	% of Mineral Admixtures	Compressive Strength MPa	Tensile Strength MPa	Flexural Strength MPa
1.	M60 Control Mix	1:1.11:2.09 W/C = 0.3	0	60.67	4.14	7.95
2.	(5+5) (SF+MK) 1% SP	1:1.08:2.09 W/B = 0.3	10	65.78	3.54	7.87
3.	(5+5) % (SF+MK) 1.5% SP	1:1.08:2.09 W/B = 0.3	10	61.33	4.24	8.12
4.	(5+10) % (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	64.44	3.68	5.40
5.	(5+10) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	57.78	3.53	7.87
6.	(10+5)% (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	59.20	3.42	5.40
7.	(10+5)% (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	61.54	2.83	5.8
8.	(7.5+7.5) % (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	65.77	4.24	8.00
9.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	67.11	4.38	8.75
10.	(10+10) % (SF+MK) 1% SP	1:1.05:2.09 W/B = 0.3	20	58.67	3.54	5.62
11.	(10+10) % (SF+MK) 1.5% SP	1:1.05:2.09 W/B = 0.3	20	63.56	2.55	7.75

Table 6. Test Results of Mechanical Properties of High Strength Concrete with the addition of multi-mineral admixtures at 56 days

S. No.		Mix Proportion	% of Mineral Admixtures	Compressive Strength MPa	Tensile Strength MPa	Flexural Strength MPa
1.	M60 Control Mix	1:1.11:2.09 W/C = 0.3	0	63.15	4.31	8.26
2.	(5+5) (SF+MK) 1% SP	1:1.08:2.09 W/B = 0.3	10	68.60	3.69	8.19
3.	(5+5) % (SF+MK) 1.5% SP	1:1.08:2.09 W/B = 0.3	10	64.08	4.43	8.46
4.	(5+10) % (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	67.46	3.85	5.64
5.	(5+10) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	60.61	3.70	8.23
6.	(10+5)% (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	62.21	3.59	5.66
7.	(10+5)% (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	64.80	2.98	6.09
8.	(7.5+7.5) % (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	69.38	4.47	8.42
9.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	70.93	4.63	9.23
10.	(10+10) % (SF+MK) 1% SP	1:1.05:2.09 W/B = 0.3	20	62.13	3.75	5.94
11.	(10+10) % (SF+MK) 1.5% SP	1:1.05:2.09 W/B = 0.3	20	67.43	2.70	8.20

Table 7. Test Results of Mechanical Properties of High Strength Concrete with the addition of multi-mineral admixtures at 90 days

S. No.	Mix Designation	Mix Proportion	% of Mineral Admixtures	Compressive Strength MPa	Tensile Strength MPa	Flexural Strength MPa
1.	M60 Control Mix	1:1.11:2.09 W/C = 0.3	0	66.85	4.55	8.61
2.	(5+5) (SF+MK 1% SP	1:1.08:2.09 W/B = 0.3	10	72.62	3.90	8.65
3.	(5+5) % (SF+MK) 1.5% SP	1:1.08:2.09 W/B = 0.3	10	67.83	4.68	8.94
4.	(5+10) % (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	71.39	4.07	5.96
5.	(5+10) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	64.13	3.91	8.70
6.	(10+5)% (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	65.83	3.79	5.98
7.	(10+5)% (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	68.55	3.14	6.43
8.	(7.5+7.5) % (SF+MK) 1% SP	1:1.07:2.09 W/B = 0.3	15	73.39	4.72	8.89
9.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	15	75.02	4.89	9.74
10.	(10+10) % (SF+MK) 1% SP	1:1.05:2.09 W/B = 0.3	20	65.71	3.96	6.27
11.	(10+10) % (SF+MK) 1.5% SP	1:1.05:2.09 W/B = 0.3	20	71.31	2.85	8.66

Table 8. Effect of percentage of replacement of multi-mineral admixtures on compressive strength of M60 grade High Strength Concrete at 1% SP

S. No.	Mix Designation	% of Mineral Admixtures	Compressive Strength (MPa)		
			28 Days	56 Days	90 Days
1.	M60 Control Mix	0	60.67	63.15	66.85
2.	(5+5) (SF+MK) 1% SP	10	65.78	68.60	72.62
3.	(5+10) % (SF+MK) 1% SP	15	64.44	67.46	71.39
4.	(10+5)% (SF+MK) 1% SP	15	59.20	62.21	65.83
5.	(7.5+7.5) % (SF+MK) 1% SP	15	65.77	69.38	73.39
6.	(10+10) % (SF+MK) 1% SP	20	58.67	62.13	65.71

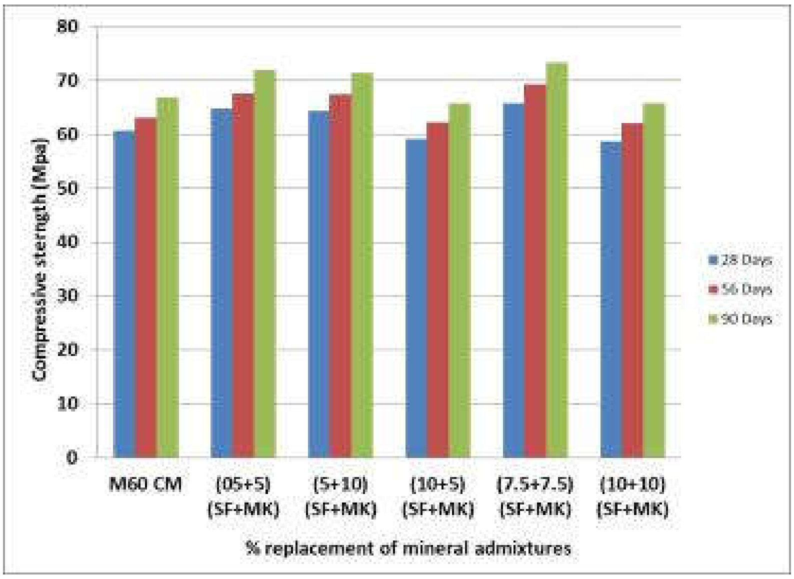

Fig. 6. Graph showing variations in Compressive Strength of Concrete at 1%SP

Table 9. Effect of percentage of replacement of multi-mineral admixtures on compressive strength of M60 grade High Strength Concrete at 1.5%SP

S. No.	Mix Designation	% of Mineral Admixtures	Compressive Strength (MPa)		
			28 Days	56 Days	90 Days
1.	M60 Control Mix	0	60.67	63.15	66.85
2.	(5+5) (SF+MK) 1.5% SP	10	61.33	64.08	67.83
3.	(5+10) % (SF+MK) 1.5% SP	15	57.78	60.61	64.13
4.	(10+5)% (SF+MK) 1.5% SP	15	61.54	64.80	68.55
5.	(7.5+7.5) % (SF+MK) 1.5% SP	15	67.11	70.93	75.02
6.	(10+10) % (SF+MK) 1.5% SP	20	63.56	67.43	71.31

strength value is higher for the trail mix (7.5SF+7.5MK) with 1% SP, found to be higher compared with other trail mixes. From the above graph, it is observed that the compressive strength value is higher for the trail mix (7.5SF+7.5MK) with 1.5% SP, found to be higher compared with other trail mixes. Hence, it is considered for further study to improve the ductility of the high strength concrete.

From the above graph, it is observed that the tensile strength value is higher for the trail mix (7.5SF+7.5MK) with 1.5% SP, found to be higher compared with other trail mixes. From the above graph, it is observed that the tensile strength value is higher for the trail mix (7.5SF+7.5MK) with 1% SP, found to be higher compared with other trail mixes.

Table 10. Effect of percentage of replacement of multi-mineral admixtures on Tensile Strength of M60 grade High Strength Concrete at 1%SP

S. No.	Mix Designation	% of Mineral Admixtures	Tensile Strength (MPa)		
			28 Days	56 Days	90 Days
1.	M60 Control Mix	0	4.14	4.31	4.55
2.	(5+5) (SF+MK) 1% SP	10	3.54	3.69	3.90
3.	(5+10) % (SF+MK) 1% SP	15	3.68	3.85	4.07
4.	(10+5)% (SF+MK) 1% SP	15	3.42	3.59	3.79
5.	(7.5+7.5) % (SF+MK) 1% SP	15	4.24	4.47	4.72
6.	(10+10) % (SF+MK) 1% SP	20	3.54	3.75	3.96

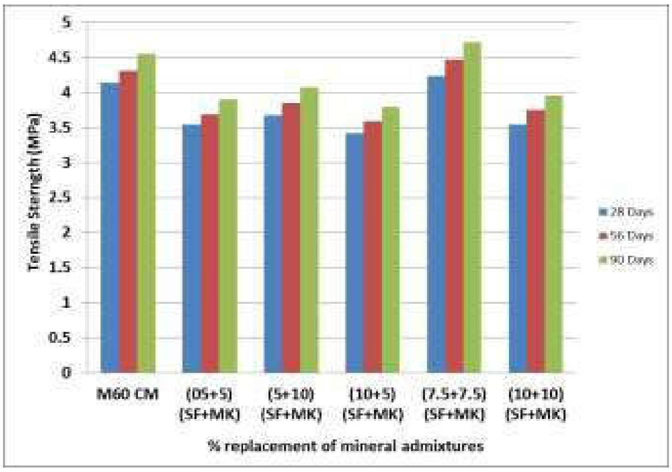

Fig. 8. Graph showing variations in Tensile Strength of concrete at 1% SP

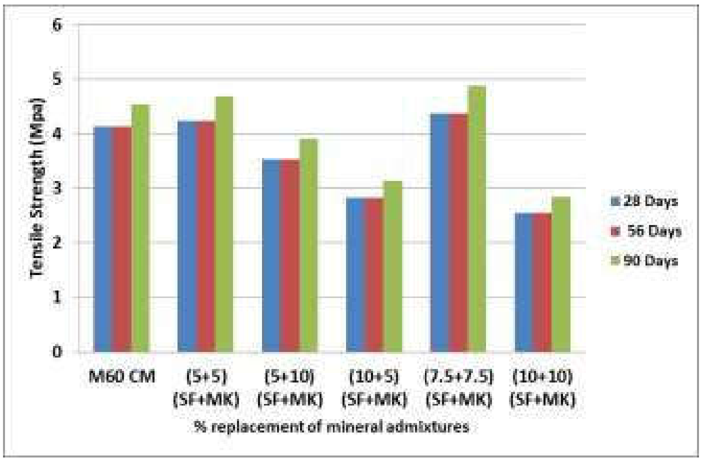

Fig. 9. Graph showing variations in Tensile Strength of concrete at 1.5% SP

Table 11. Effect of percentage of replacement of multi-mineral admixtures on Tensile Strength of M60 grade High Strength Concrete at 1.5%SP

S. No.	Mix Designation	% of Mineral Admixtures	Tensile Strength (MPa)		
			28 Days	56 Days	90 Days
1.	M60 Control Mix	0	4.14	4.14	4.55
2.	(5+5) (SF+MK) 1.5% SP	10	4.24	4.24	4.68
3.	(5+10) % (SF+MK) 1.5% SP	15	3.53	3.53	3.91
4.	(10+5)% (SF+MK) 1.5% SP	15	2.83	2.83	3.14
5.	(7.5+7.5) % (SF+MK) 1.5% SP	15	4.38	4.38	4.89
6.	(10+10) % (SF+MK) 1.5% SP	20	2.55	2.55	2.85

Table 12. Effect of percentage replacement of multi-mineral admixtures on Flexural Strength of M60 grade High Strength Concrete at 1%SP

S. No.	Mix Designation	% of Mineral Admixtures	Flexural Strength (MPa)		
			28 Days	56 Days	90 Days
1.	M60 Control Mix	0	7.95	8.26	8.61
2.	(5+5) (SF+MK) 1% SP	10	7.87	8.19	8.65
3.	(5+10) % (SF+MK) 1% SP	15	5.40	5.64	5.96
4.	(10+5)% (SF+MK) 1% SP	15	5.40	5.66	5.98
5.	(7.5+7.5) % (SF+MK) 1% SP	15	8.00	8.42	8.89
6.	(10+10) % (SF+MK) 1% SP	20	5.62	5.94	6.27

Table 13. Effect of percentage replacement of multi-mineral admixtures on Flexural Strength of M60 grade High Strength Concrete at 1.5%SP

S. No.	Mix Designation	% of Mineral Admixtures	Flexural Strength (MPa)		
			28 Days	56 Days	90 Days
1.	M60 Control Mix	0	7.95	8.26	8.61
2.	(5+5) (SF+MK) 1.5% SP	10	8.12	8.46	8.94
3.	(5+10) % (SF+MK) 1.5% SP	15	7.87	8.23	8.70
4.	(10+5)% (SF+MK) 1.5% SP	15	5.8	6.09	6.43
5.	(7.5+7.5) % (SF+MK) 1.5% SP	15	8.75	9.23	9.74
6.	(10+10) % (SF+MK) 1.5% SP	20	7.75	8.20	8.66

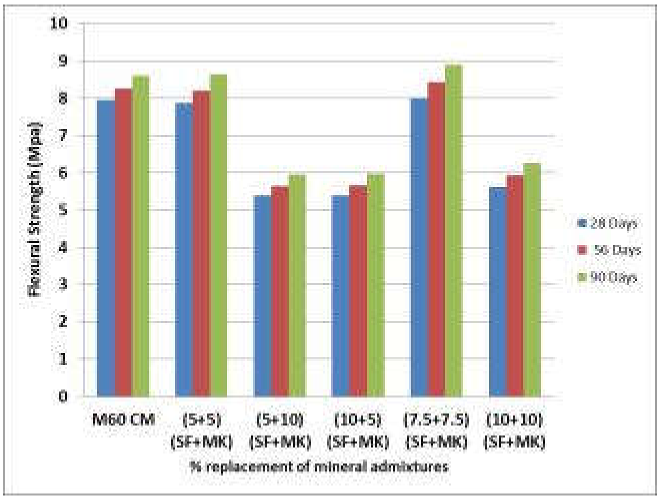

Fig. 10. Graph showing variations in Flexural Strength of concrete at 1% SP

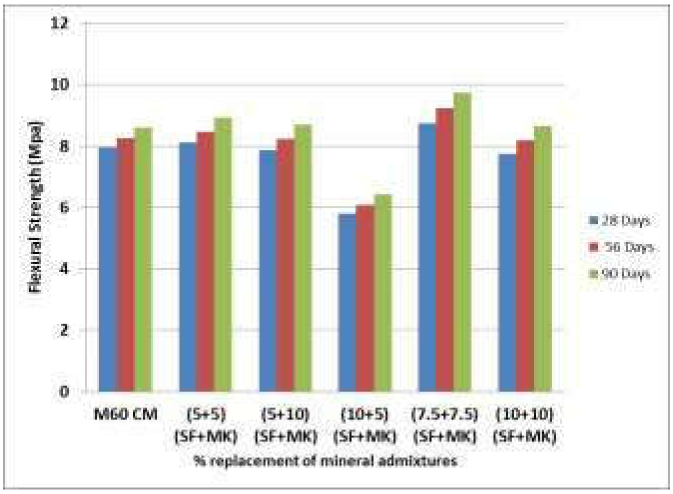

Fig. 11. Graph showing variations in Flexural Strength of concrete at 1.5% SP

Table 14. Mechanical properties various proportions of steel fibers on M60 grade high Strength Concrete at 28 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Compressive Strength MPa	Tensile Strength MPa	Flexural Strength MPa
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	72.4	5.09	9.75
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	74.6	5.37	11.25
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	77.7	5.65	12.25
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	76.8	5.51	11.75

Table 15. Mechanical properties various proportions of steel fibers on M60 grade high Strength Concrete at 56 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Compressive Strength MPa	Tensile Strength MPa	Flexural Strength MPa
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	75.29	5.29	10.18
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	77.95	5.63	11.86
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	81.97	5.98	13.04
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	81.40	5.89	12.57

Table 16. Mechanical properties various proportions of steel fibers on M60 grade high Strength Concrete at 90 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Compressive Strength MPa	Tensile Strength MPa	Flexural Strength MPa
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	79.27	5.54	10.57
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	82.43	5.90	12.31
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	86.66	6.27	13.53
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	86.01	6.17	13.04

Table 17. Compressive Strengths of various proportions of steel fibers on M60 grade High Strength Concrete

S. No.	**Mix Designation**	**% of** Steel Fibers	**Compressive Strength (MPa)** 28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	0.5	72.4	75.29	79.27
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1.0	74.6	77.95	82.43
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1.5	77.7	81.97	86.66
4.	(7.5+7.5) % (SF+MK) 1.5% SP	2	76.8	80.64	85.74

Table 18. Tensile Strengths of various proportions of steel fibers on M60 grade High Strength Concrete

S. No.	Mix Designation	% of Steel Fibers	Tensile Strength (MPa) 28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	0.5	5.09	5.29	5.54
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1.0	5.37	5.63	5.90
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1.5	5.65	5.98	6.27
4.	(7.5+7.5) % (SF+MK) 1.5% SP	2	5.51	5.89	6.17

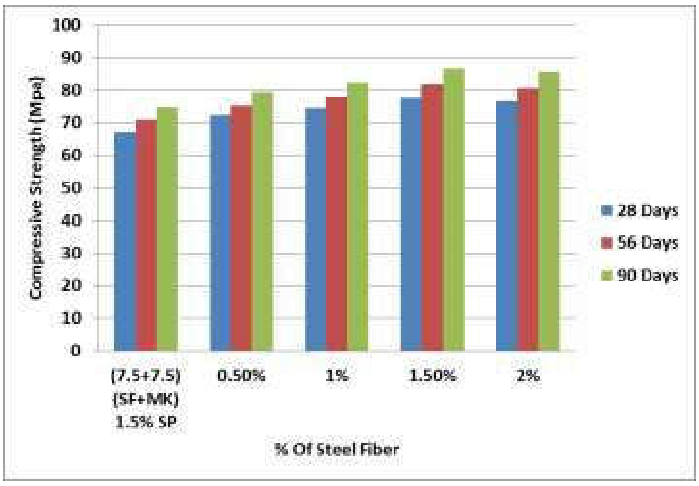

Fig. 12. Variation of Compressive Strengths by incorporating Steel Fibers

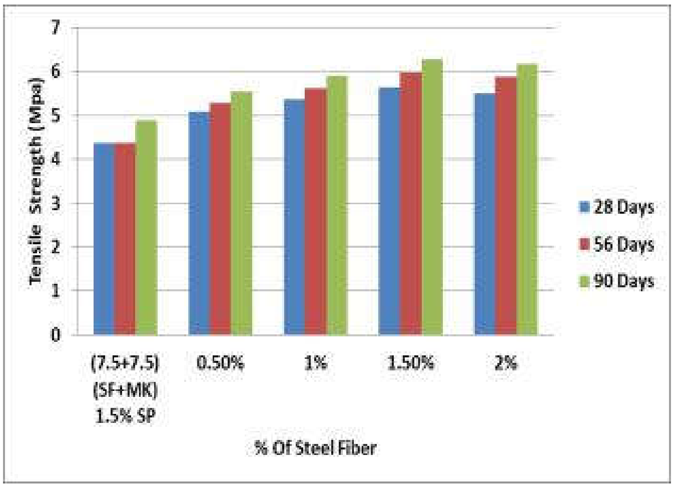

Fig. 13. Variation of Tensile Strengths by incorporating Steel Fibers

Table 19. Flexural Strengths of various proportions of steel fibers on M60 grade High Strength Concrete

S. No.	Mix Designation	% of Steel Fibers	Flexural Strength (MPa)		
			28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	0.5	9.75	10.18	10.57
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1.0	11.25	11.86	12.31
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1.5	12.25	13.04	13.53
4.	(7.5+7.5) % (SF+MK) 1.5% SP	2	11.75	12.57	13.04

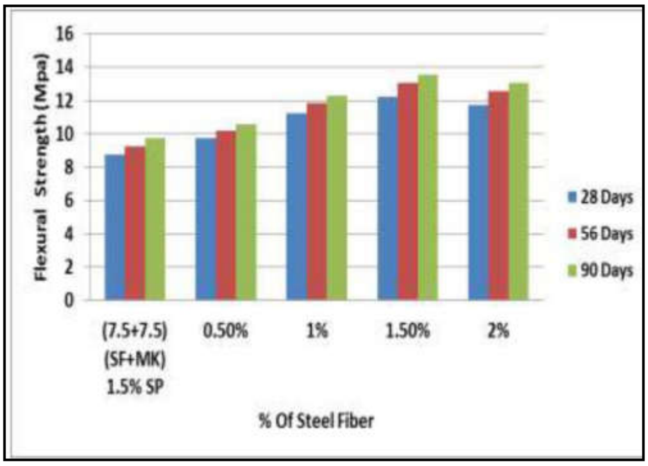

Fig. 14. Variation of Flexural Strengths by incorporating Steel Fibers

Durability Test by (H2SO4)

Table 20. Test Results for chemical Properties of High Strength Concrete durability test by H_2SO_4 of 1% for 28 days

S. No.	*Mix Designation*	*Mix Proportion*	*% of Steel Fibers*	*Compressive Strength MPa*		
				28 Days	*56 Days*	*90 Days*
1.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*0.5*	*72.0*	*69.84*	*67.68*
2.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*1.0*	*74.3*	*71.70*	*69.47*
3.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*1.5*	*77.65*	*74.02*	*71.68*
4.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*2*	*76.60*	*72.77*	*70.47*

Table 21. Test Results for chemical Properties of High Strength Concrete durability test by H2SO4 of 1% for 56 days

S. No.	***Mix Designation***	***Mix Proportion***	***% of Steel Fibers***	***Tensile Strength (MPa)***		
				28 Days	*56 Days*	*90 Days*
1.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*0.5*	*4.85*	*4.65*	*4.53*
2.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*1.0*	*4.97*	*4.77*	*4.62*
3.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*1.5*	*5.5*	*5.22*	*5.06*
4.	*(7.5+7.5) % (SF+MK) 1.5% SP*	*1:1.07:2.09 W/B = 0.3*	*2*	*5.23*	*4.9*	*4.78*

Table 22. Test Results for chemical Properties of High Strength Concrete durability test by H2SO4 of 1% for 90 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Flexural Strength (MPa)		
				28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	9.35	8.99	8.77
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	10.90	10.44	10.17
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	11.85	11.20	10.90
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	11.35	11.05	10.40

Table 23. Test Results for chemical Properties of High Strength Concrete durability test by H2SO4 of 3% for 28 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Compressive Strength MPa		
				28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	69.5	66.72	64.63
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	73.80	70.47	68.26
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	77.00	72.76	70.45
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	76.02	71.44	69.16

Table 24. Test Results for chemical Properties of High Strength Concrete durability test by H2SO4 of 1% for 56 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Tensile Strength (MPa)		
				28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	4.35	4.15	4.02
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	4.47	4.24	4.11
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	5.04	4.70	4.55
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	4.85	4.53	4.38

Table 25. Test Results for chemical Properties of High Strength Concrete durability test by H_2SO_4 of 3% for 28 days

S. No.	Mix Designation	Mix Proportion	% of Steel Fibers	Flexural Strength (MPa)		
				28 Days	56 Days	90 Days
1.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	0.5	8.80	8.37	8.11
2.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.0	10.30	9.76	9.43
3.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	1.5	11.55	10.82	10.45
4.	(7.5+7.5) % (SF+MK) 1.5% SP	1:1.07:2.09 W/B = 0.3	2	10.85	10.09	9.76

From the above graph, it is observed that the flexural strength value is higher for the trail mix (7.5SF+7.5MK) with 1.5% SP, found to be higher compared with other trail mixes.

Conclusions

Based on the experimental investigations conducted on the casted cubes, cylinders and prisms, the following conclusions were drawn. Addition of Silica Fume and Metakaoline to concrete significantly affected the strength parameters of concrete. Concrete with (7.5%SF+7.5% MK) with 1% SP when compared with the control mix and other trial mixes, showed an increase in compressive, tensile and flexural strengths 8.4%, 2.41%, 0.62% respectively. Concrete with (7.5%SF+7.5% MK) with 1.5% SP when compared with the control mix and other trial mixes, showed an increase in compressive, tensile and flexural strengths of 10.61%, 5.79% ,10% respectively. Concrete with (7.5%SF+7.5% MK) with 1.5% SP and 1.5% Steel Fiber when compared with the control mix, showed an increase in compressive, tensile and flexural strength of 28.06%, 36.47%, 54.08% respectively. The incorporation of the steel fibers in the High Strength mix has significantly improved the tensile strength of the concrete.

REFERENCES

Dr. Salahldein Alsadey "Influence of Superplasticizer on Strength of Concrete", *International Journal of Research in Engineering and Technology*, Vol.1, No.3, 2012.

Eswari, S., P.N. Raghunath and K. Suguna," Ductility Performance of Hybrid Fibre Reinforced Concrete", *American Journal of App lied Sciences* 5 (9): 1257-1262, 2008, ISSN 1546-9239, 2008 Science Publications.

Muthupriya, P. Subramanian, K.B.G.Vishnuram, "Experimental Investigation on High Performance Reinforced Concrete Column with Silica Fume and Fly Ash as admixtures". Asian Journal of Civil Engineering, Vol.12, No.5 (2011), Pages 597-618.

Patil, B.B., P.D. Kumbhar "Strength and Durability Properties of high Performance Concrete incorporating High Reactivity Metakaolin", *International Journal of Modern Engineering Research*, Vol.2, issue.3,May-June 2012,pages 1099-1104.

Ravichandran, A., K.Suguna and P.N.Raghunath "Strength Modeling of High-strength concrete with Hybrid Fiber Reinforcement". *American Journal of Applied Sciences* 6 (2):219-233, 2009.

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