"EXPERIMENTAL INVESTIGATION ON STRENGTH CHARACTERISTICS OF COMPOSITE FIBRE HIGH-PERFORMANCE CONCRETE WITH COMBINATION OF THREE MINERAL ADMIXTURES"

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Abstract - *In this thesis, a study had been made for the development of High Performance Concrete using mineral admixtures such as Fly-ash, Silica-fume and Metakoalin along with steel and Polypropylene fibers. The compressive strength, split tensile strength and flexural strength of the plain concrete specimens without any mineral admixture & fibers have been compared with that of compressive-strength, split-tensile strength and flexural-strength of composite concrete made up of mineral admixtures & fibers for different W/B ratios.HPC is a Composite material which having superior mechanical properties. The addition of fly-ash, silica-fume & Metakoalin influences the overall behavior of this concrete. The experimental studies of 6 sets of concrete specimens were carried out, the main parameters that are varied are mineral admixtures additions (silicafume, flyash & metakaolin) of percentage 0% 15% &22.5% (each by 5% & 7.5 %) fiber-volume (0 to 0.5% steel fibres and 0.25% polypropylene fibres), water-binder ratio's (0.30,0.35 & 0.40). The Behavior of the HPC specimens in compressive strength, flexure and split tensile strength was calculated. Due to the addition of mineral admixtures & fiber volume into the mix, it gives very good performance & Suitable for construction.*

Key Words: Silica fume, Metakaolin, Flyash, steel fiber, polypropylene fiber, super plasticizer, strength properties.

1. INTRODUCTION

Concrete is a construction material which is significantly using all over the world due to its very high strength & structural stability, proportionate workability and is using for various construction in the civil engineering field like dams, carriage way(pavements), short and long span bridges, building frame etc. Composite material like concrete which is made up of coarse material mixed in cement which fills between the gaps of aggregate materials & joined them together and create a perfect bond. Now a day's concrete is highly using as a construction material. The characteristics of conventional concrete like workability, durability and others required to be modify to become suitable for all the environmental conditions. So that the mineral admixtures are becoming the alternate solution for increasing the pozzolonic activity because of presence of finer particles in that. The conventional concrete is having very low tensile strength and not tough in nature. The usage of fibers in normal concrete increases the tensile strength. On the other hand to increase the mechanical properties of the normal concrete artificial fibres are commonly use in practice like polypropylene, polyester etc. To lower the W/B ratio and to gain the high strength, to make workable and fluid, the super plasticizers are used in making the high performance concrete.

HPC can be defined as concrete which meet the special performance and requirements that cannot achieved by the ordinary material and normal mixing, placing and curing practices. HPC overcomes the properties of conventional concrete. For making specially designed concrete the special materials are required to meet requirements like special mixing, placing and curing practices needed to handle the special type of concrete known as high performance concrete.

(1) Ch. Kusuma keerthi, k. Rajasekhar. By replacing the cement by 15% of fly ash and 5% of metakaolin, the maximum compressive strength can achieved in M80 grade concrete is up to 89.3 Mpa.

(2) Erhan Guneyisi et al (2012) made an experimental investigation to find the effects of metakaolin and silica fume on the mechanical properties of concrete like shrinkage sand durability related to permeability of HPC. By

compressive and split-tensile strength the mechanical properties is determined.

(3) Dr. B. Vidivelli, A. jayaranjini. For M60 grade of concrete the replacement of cement by 15% of mineral admixtures i.e. 10% Flyash and 5% Silica fume, the compressive strength is 61.5 Mpa.

(4) Arfath khan, Md, Abdul Wahab, B. Dean Kumar. In this experimental investigation the cement is replaced by condensed silica fume and metakaolin with different percentage 0-15% and steel fiber is 0-1.5%. The highest compressive strength is obtained in a concrete is with 10% of condensed silica fume & 5% of metakaolin & 1.5% of steel fiber.

MATERIALS

1) Cement (OPC): Ultra tech cement 43 grade was used. Specific gravity of 3.10.

2) Coarse aggregate: - Crushed granite metal with 60% passing 20 mm & retained on 12.5 mm sieve and 40% passing 12.5 mm & retained on 4.75 mm sieve were used. The weight of aggregate was 60% of the total aggregate & Specific gravity of 2.70.

3) Fine aggregate: - River sand from local sources was used of specific gravity 2.50.

4) Water: - Water used for both mixing and curing should be free from harmful materials. Potable water is used.

5) Silica fume: - Silica fume is the very fine non crystalline silica. It is produced in electric arc furnace. Silica fume is by product of the production of elemental silicon or alloys containing silicon.

6) Fly ash: Flyash is obtained from thermal power plant at KUDTINI BELLARI THERMAL POWER STATION was used in this investigation. The specific gravity is 1.9.

7) Metakaolin is obtained from the 20 MICRON LIMITED company at vadodara in Gujarat. The specific gravity of metakaolin is 2.6. The metakaolin is in conformity with the general requirements of pozzolona.

8) Super plasticizer: To improve the workability of the concrete, a high range water reducing agent Fosrac conplast SP430 is used.

9) Steel fibres: Crimped steel fibres of 30mm length with a dia of 0.6mm and an aspect ratio of 50, density is 7840 Kg/m3 and specific gravity is 7.9 were used.

10) Polypropylene fibres: RECRON 3S TYPE-CT 2012 polypropylene fibres of density 946 Kg/m3 were used.

2. METHODOLOGY

In this project the cement is replaced by mixtures of mineral admixtures such as flyash, silica fume, and metakaolin, in ratio 0%, 15%, 22.5% (5% & 7.5% of each flyash, silica fume, and metakaolin) is used in concrete mix. The steel fiber of different dosage i.e. 0% and 0.5% is used, and 0.25% of polypropylene fiber is used in concrete mixes. Each different replacement of cement bt mineral admixtures (i.e. 0%, 15%, 22.5%) of concrete mix is done, with different water binder ratio of 0.30%, 0.35%, 0.40% with super plasticizer of 0.6% is used. By using cubes (150mmx150mmx150mm), cylinders (150mm dia and 300mm length) and prism (100mmx100mmx500mm) the different concrete mixes is cast and tests are conducted to find out compressive strength, split tensile strength and flexural strength.

Compressive strength:

Table 1: 7 days cube compressive strength for 0% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	48.17	46.66	44.11
	15%	53.55	52.08	50.33
	22.5%	46.04	43.77	42.14

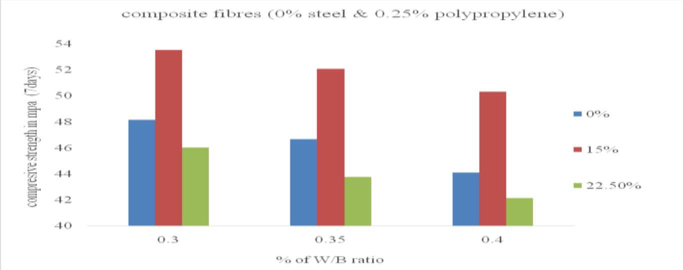

Chart 1: variation of 7 days compressive strength on different percentage of mineral admixtures & 0% steel fibres.

Table 2: 28 days cube compressive strength for 0% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	59.22	56.88	54.77
	15%	63.88	59.04	56.44
	22.5%	55.36	52.66	50.55

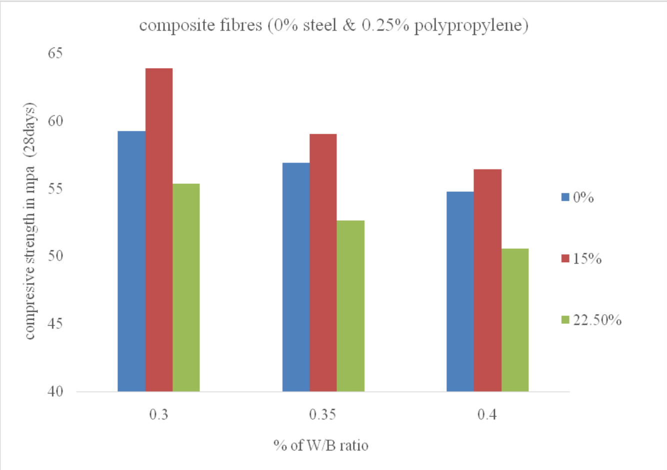

Chart 2: variation of 28 days compressive strength on different percentage of mineral admixtures & 0% steel fibres.

Table 3: 7 days cube compressive strength for 0.5% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0.5%	0%	53.33	50.66	48.44
	15%	59.88	53.08	50.32
	22.5%	52.04	48.44	46.08

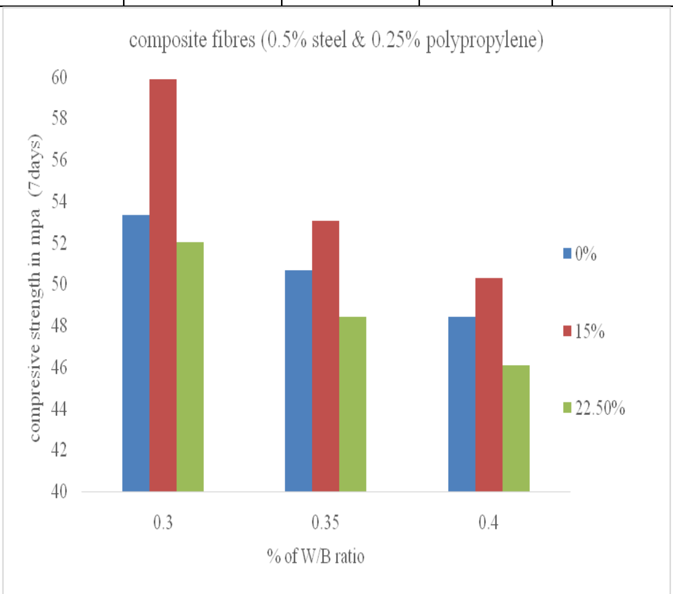

Chart 3: variation of 7 days compressive strength on different percentage of mineral admixtures & 0.5% steel fibres.

Table 4: 28 days cube compressive strength for 0.5% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0.5%	0%	65.77	62.22	60.88
	15%	72.44	65.66	63.02
	22.5%	63.33	61.11	60.44

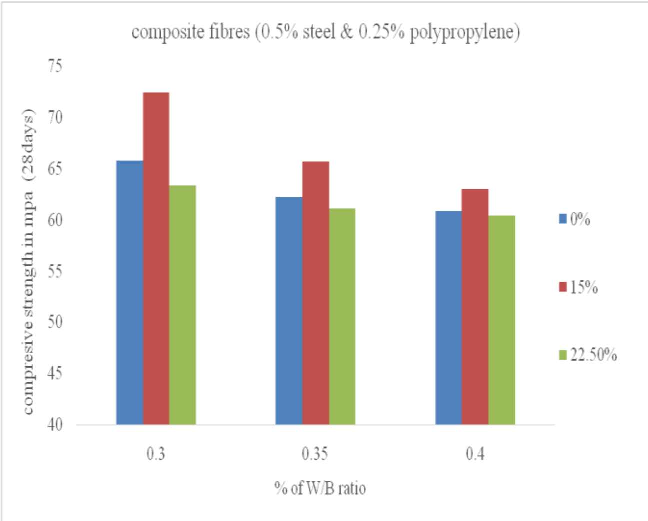

Chart 4: variation of 28 days compressive strength on different percentage of mineral admixtures & 0.5% steel fibres.

Split tensile strength:

Table 5: 7 days Split tensile strength for 0% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	4.52	4.28	4.13
	15%	4.82	4.48	4.24
	22.5%	4.28	4.12	3.91

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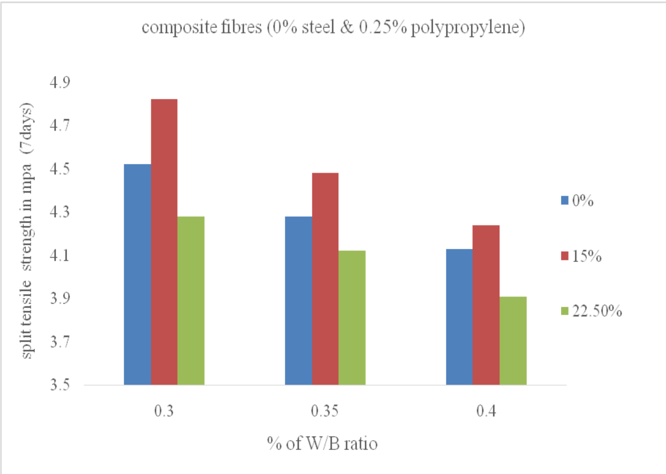

Chart 5: variation of 7 days Split tensile strength on different percentage of mineral admixtures & 0% steel fibres.

Table 6: 28 days Split tensile strength for 0% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	5.26	5.13	4.98
	15%	5.44	5.24	5.09
	22.5%	5.12	5.03	4.86

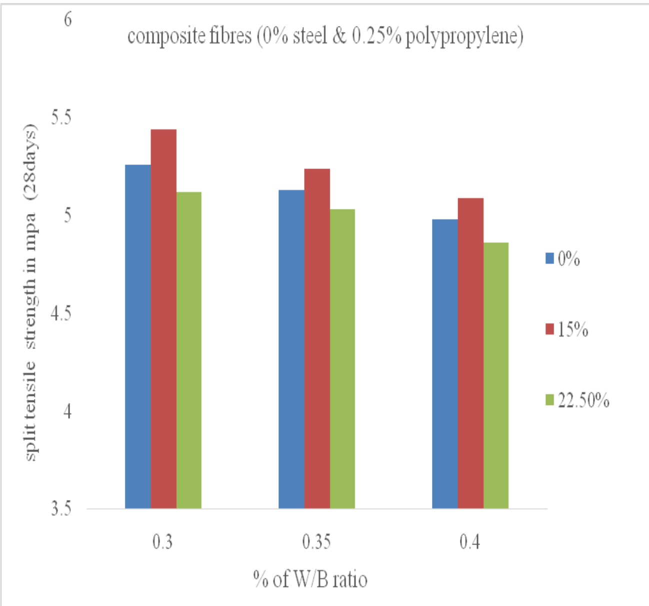

Chart 6: variation of 28 days Split tensile strength on different percentage of mineral admixtures & 0% steel fibres.

Table 7: 7 days Split tensile strength for 0.5% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0.5%	0%	4.77	4.64	4.43
	15%	5.26	4.73	4.62
	22.5%	4.68	4.41	4.27

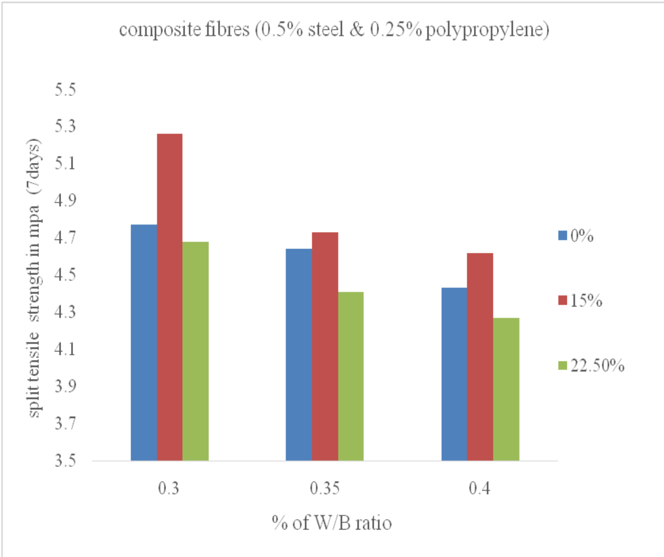

Chart 7: variation of 7 days Split tensile strength on different percentage of mineral admixtures & 0.5% steel fibres.

Table 8: 28 days Split tensile strength for 0.5% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0.5%	0%	5.66	5.42	5.24
	15%	5.84	5.61	5.38
	22.5%	5.48	5.31	5.03

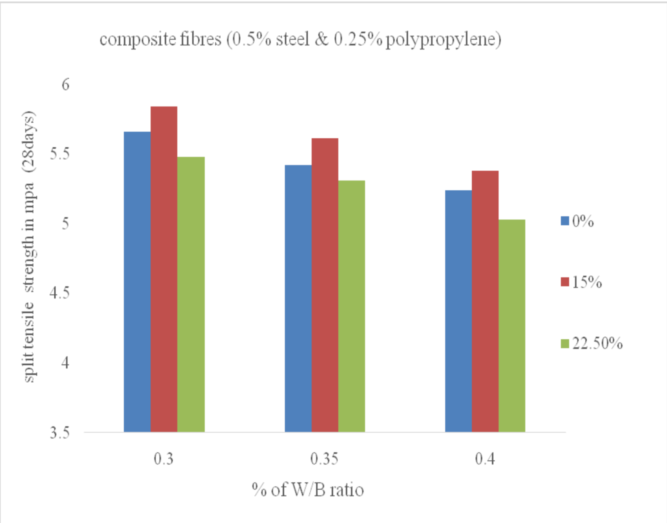

Chart 8: variation of 28 days Split tensile strength on different percentage of mineral admixtures & 0.5% steel fibres.

Flexural strength:

Table 9: 7 days Flexural strength for 0% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	5.34	5.18	4.88
	15%	5.77	5.31	5.14
	22.5%	5.22	5.03	4.67

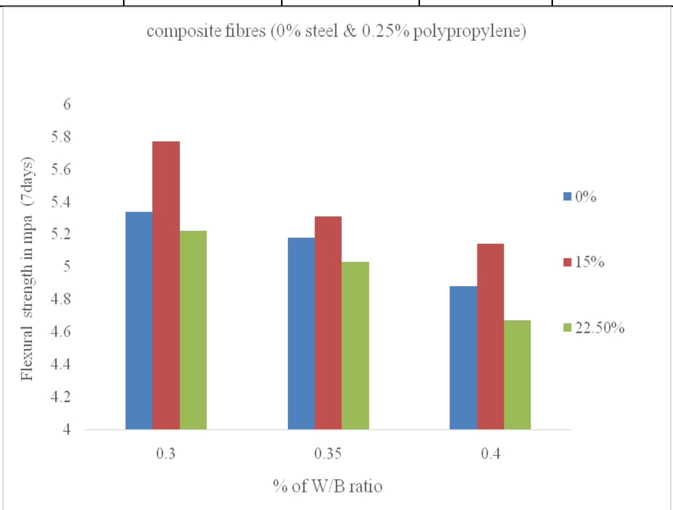

Chart 9: variation of 7 days flexural strength on different percentage of mineral admixtures & 0% steel fibres.

Table 10: 28 days flexural strength for 0% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	6.24	6.08	5.82
	15%	6.88	6.21	5.97
	22.5%	6.11	5.87	5.63

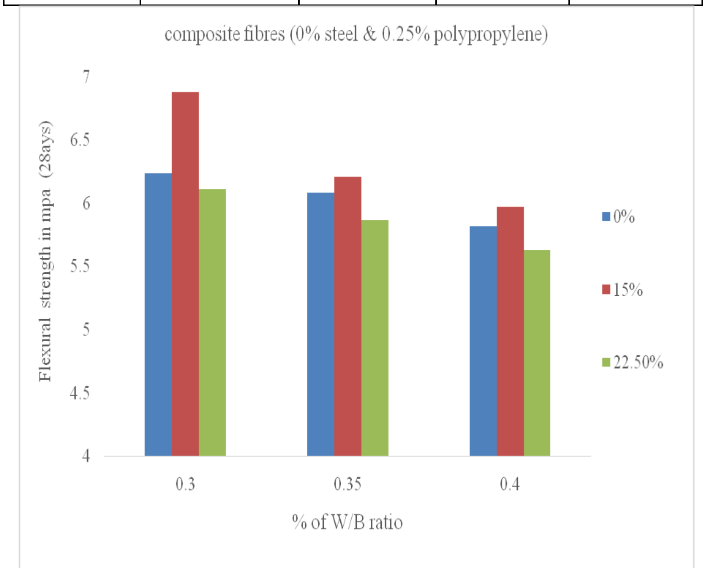

Chart 10: variation of 28 days flexural strength on different percentage of mineral admixtures & 0% steel fibres.

Table 11: 7 days Flexural strength for 0.5% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	5.77	5.48	5.21
	15%	6.19	5.74	5.45
	22.5%	5.68	5.37	5.08

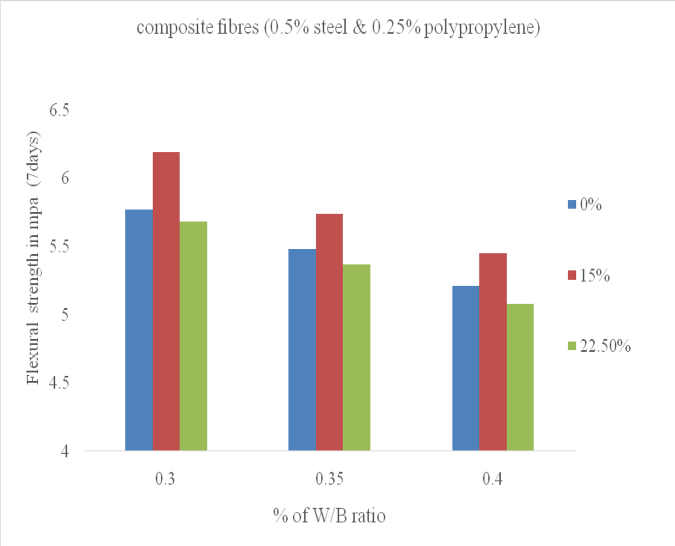

Chart 11: variation of 7 days flexural strength on different percentage of mineral admixtures & 0.5% steel fibres.

Table 12: 28 days flexural strength for 0.5% steel fiber & different percentage of mineral admixtures.

% of fiber	% of mineral admixtures	W/B ratios		
		0.30	0.35	0.40
0%	0%	6.76	6.42	6.21
	15%	7.42	6.73	6.38
	22.5%	6.61	6.36	6.07

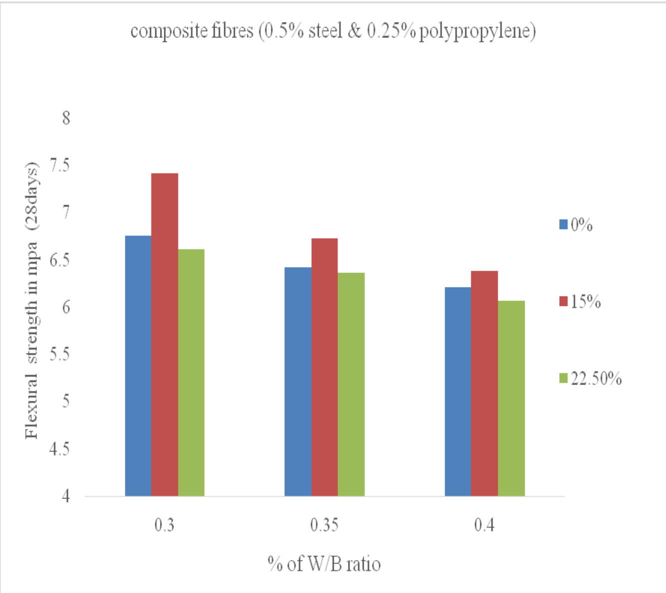

Chart 12: variation of 28 days flexural strength on different percentage of mineral admixtures & 0.5% steel fibres.

3. CONCLUSIONS

1. Addition of admixtures to the concrete increases the strength of high performance concrete.

2. The strength of high performance concrete increases with increase in % of mineral admixtures. The maximum strength is observed at 15% and further increase in % of mineral admixture to 22.5% decreases the strength of HPC.

3. The compressive strength at 15% for 7 days is 53.55 N/mm2 for 0.30 W/B ratio. There is a increase of cube compressive strength by 11.17% when compared with plain HPC mix. It is also observed that at 28 days the compressive strength is 63.88 N/mm2, there is a increase of compressive strength by 7.86% when compared to plain HPC mix.

4. The addition of fibres increases the strength of high performance concrete. At 0.5% of fibre the increase in compressive strength at 15% mineral admixture for 7 days is 11.82% compared with plain HPC mix. The compressive strength at 28 days is increased by 13.40% when compared with plain HPC mix.

5. The split tensile strength at 15% mineral admixture & 0.30 W/B ratio for 7 days, there is a increase in split tensile strength by 6.64% over plain HPC mix. For 22.5% mineral admixture there is a decrease in split tensile strength by 5.31% when compared with plain high performance concrete mix. At 28 days the split tensile strength is increases by 3.42% for 15% mineral admixture & there is a decrease in split tensile strength by 2.66% when compare with plain HPC mix.

6. At 0.5% of fiber the increase in split tensile strength at 15% mineral admixture for 7 days is 16.37% compared with plain HPC mix. The split tensile strength at 28 days is increased by 11.02% when compared with plain HPC mix.

7. The Flexural strength at 15% mineral admixture & 0.30 W/B ratio for 7 days there is a increase in flexural strength by 8.05% over plain HPC mix. For 22.5% mineral admixture there is a decrease in flexural strength by 2.24% when compared with plain HPC mix. At 28 days the flexural strength is increases by 10.25% for 15% mineral admixture & there is a decrease in flexural strength by 2.08% when compare with plain HPC mix.

8. At 0.5% of fiber the increase in flexural strength at 15% mineral admixture for 7 days is 15.91% compared with HPC mix. The flexural strength at 28

days is increased by 18.91% when compared with plain HPC mix.

9. Cement can be replaced maximum by 15% (5% each mineral admixture) to achieve maximum compressive strength, split tensile strength & flexural strength for 7 and 28 days.

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