

Influence of Elevated Temperature on Compressive Strength and Split tensile Strength of Fiber Reinforced Concrete

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Abstract

In present scenario concrete is being used widely in the construction that might be exposed to elevated temperatures. Different materials were used in the concrete mixes of M 50 have been designed along with crimped steel fibers from 0.5-4% by weight of ordinary Portland cement and river sand was used. Specimens were made and subjected to room temperature, 100, 200, 300, 400 and 500°C. In this study the relation between compressive and split tensile strength value is discussed. Regression analysis is used to obtain this type of relation. This exploration developed some significant data on the properties of concrete exposed to elevated temperatures up to 500°C.

Keywords: Steel fiber, Split tensile Strength, compression, elevated temperature,

INTRODUCTION

Innovative technique of reinforced concrete structures subjected to fire has been discussed by researchers in various ways. This demonstrates much attention towards the development of fire-resistant structures. Therefore, with the low probability of fire occurrence, prescriptive design concepts provided by many codes and standards around the world can lead uneconomical designs. Fibers have widely been used to improve the ductility of concrete. Also more concentration is given to the mechanical properties of concrete after being exhibited to elevated temperatures. Due to negligence of the interaction between the different reinforced concrete members in an assembly or an entire building subjected to fire can lead to unsafe designs. Hence, performance based design has increasingly become a major means of attaining safe, and economic designs for fire-resistant structures.

PROBLEM DESCRIPTION

Steel Fibers:

Steel fibers following to ASTM A 820 type -I are used for experimental work and for all the specimens. Fibers are high tensile steel cold drawn wire and specially made for use in concrete. The length of fibers is 50mm and with average aspect ratio 50. The steel fiber has bright appearance of clean wire and has a tensile strength of value 1000Mpa.

Experimental Program:

The Ordinary portland cement affirming to IS 12269 were used with the fine and coarse aggregates approving to IS 383. The fineness modulus of sand was 2.803 and that for coarse aggregates were 7.52. The M-50 grade of concrete having mix ratios 1: 1.472: 3.043: 0.35 i.e. Cement: Fine aggregate: Coarse aggregate (10mm and 20mm) with ratio of 0.35 was used for complete experimental program.

RESULT AND DISCUSSION

Concrete is not an identical material and structurally concrete may be said that the particles of coarse aggregate are held together in a cement-sand mortar matrix. The concrete is manufactured under strict laboratory control, because of its different structure properties a certain amount of

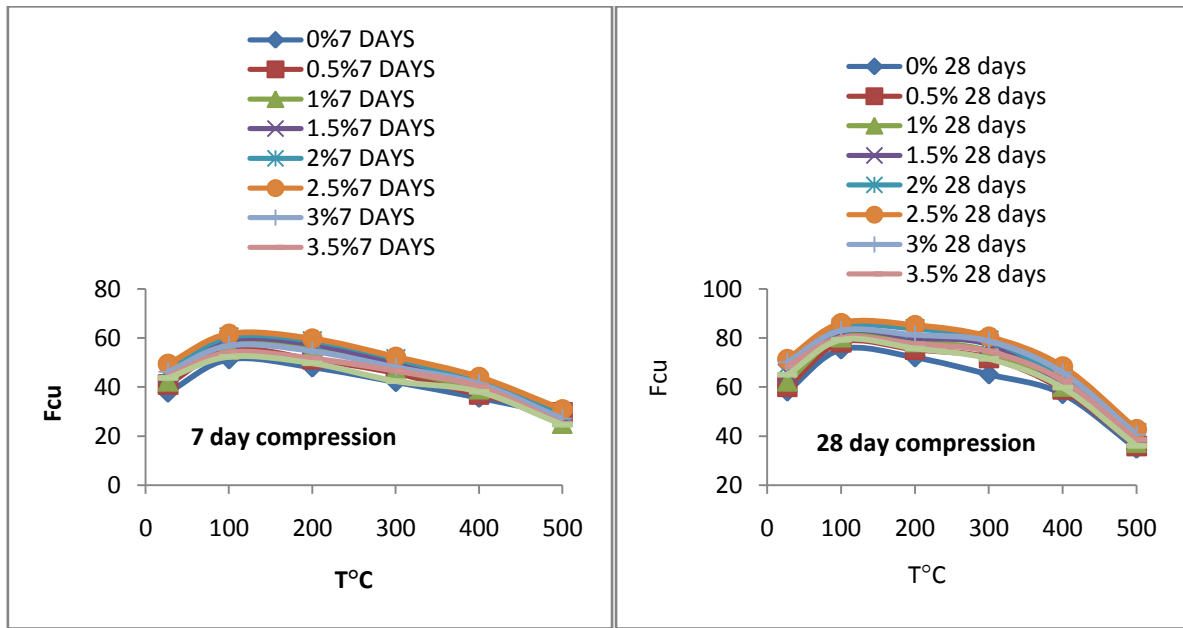
variation in the test results is to be expected. Therefore the results and discussion may be combined into a common section or separately. The test results of compression and split tensile strength are listed in the following tables and with the test results different graphs are plotted with a fiber interval of 0.5-4%.

Table .1 Compression strength 7& 28 days strength

% steel fiber	7& 28 days compressive strength											
	Temperature °C											
	27		100		200		300		400		500	
	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day
0	37.82	58.27	51.38	75.42	48.04	72.13	42.13	65.2	35.73	57.2	28.62	34.98
0.5	41.11	60.13	55.42	78.36	51.33	75.33	45.73	71.96	37.02	59.11	29.87	36.04
1	42.4	62.4	58.44	80.4	55.91	78.4	47.2	74.8	39.16	60.31	25.11	37.42
1.5	45.78	65.73	59.24	82.62	57.42	80.13	49.42	77.51	40.22	61.73	27.73	39.42
2	47.2	69.02	60.49	84.27	58.93	83.82	51.6	79.2	42.13	63.6	29.2	41.42
2.5	49.47	71.42	61.73	86.13	59.82	85.33	52.4	80.62	44.22	68.44	31.02	42.84
3	46.22	70.13	57.02	83.11	54.8	81.33	48.13	78.8	41.42	65.96	27.2	40.62
3.5	44.53	68.53	54.2	80.13	51.73	77.6	46.62	74.62	40.22	62.71	25.11	38.53
4	43.82	65.11	52.4	79.33	49.73	75.82	42.44	71.6	38.22	59.82	24.71	36.13

Table .2 Split Tensile strength 7& 28 days strength

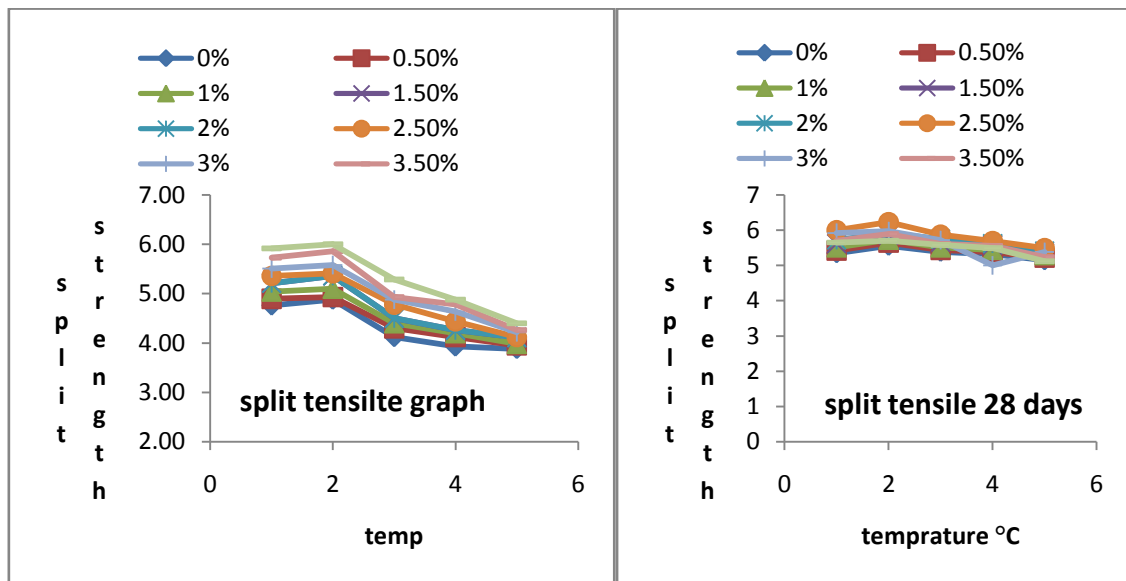
% steel fiber	7 & 28 days split tensile strength											
	Temperature °C											
	27		100		200		300		400		500	
	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day	7 day	28 day
0	4.76	5.35	4.88	5.56	4.12	5.39	3.93	5.32	3.88	5.15	3.74	4.93
0.5	4.90	5.42	4.93	5.65	4.30	5.44	4.12	5.38	3.95	5.22	3.81	4.98
1	5.04	5.51	5.10	5.73	4.40	5.51	4.20	5.44	3.98	5.29	3.84	5.04
1.5	5.21	5.62	5.36	5.86	4.50	5.66	4.26	5.58	4.11	5.35	3.92	5.21
2	5.36	5.72	5.41	5.92	4.78	5.75	4.44	5.62	4.12	5.41	3.96	5.36
2.5	5.51	6.00	5.58	6.10	4.88	5.87	4.64	5.69	4.22	5.49	4.09	5.39
3	5.73	6.10	5.86	6.23	4.93	5.92	4.78	5.73	4.26	5.58	4.12	5.44
3.5	5.92	6.22	6.00	6.31	5.29	6.01	4.88	5.87	4.40	5.66	4.20	5.51
4	5.42	5.65	5.49	5.70	4.88	5.65	4.44	5.49	4.12	5.12	3.95	4.90



Graph 1

Graph 2

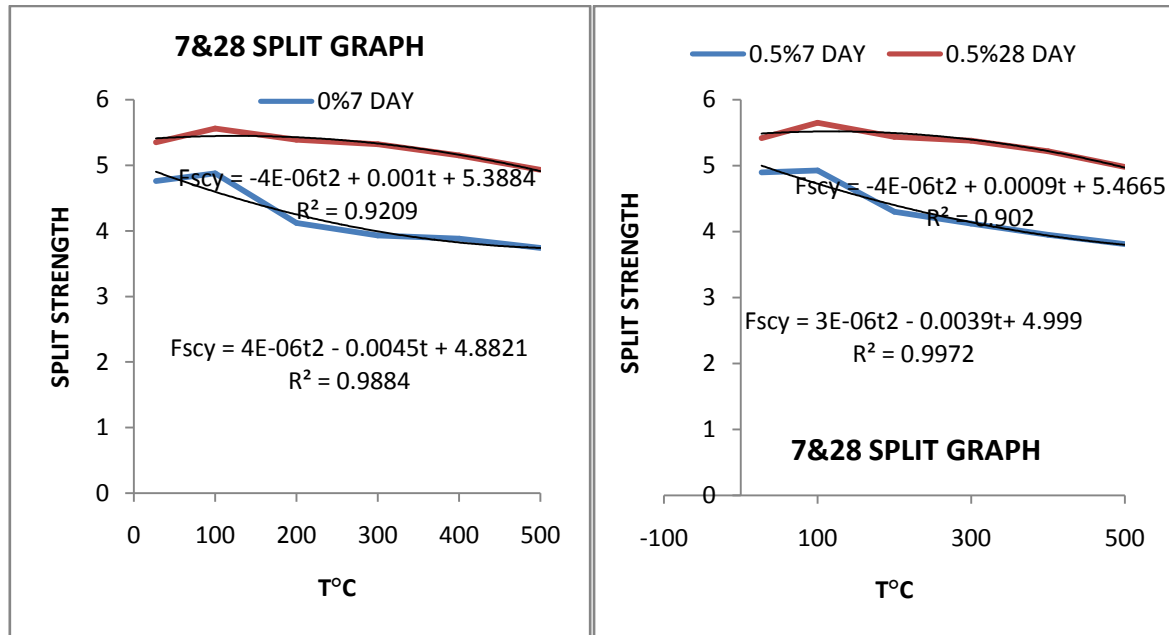
Fig.1. Graph 1 Compression strength 7 days strength **Graph 2** Compression strength 28 days strength



Graph 3

Graph 4

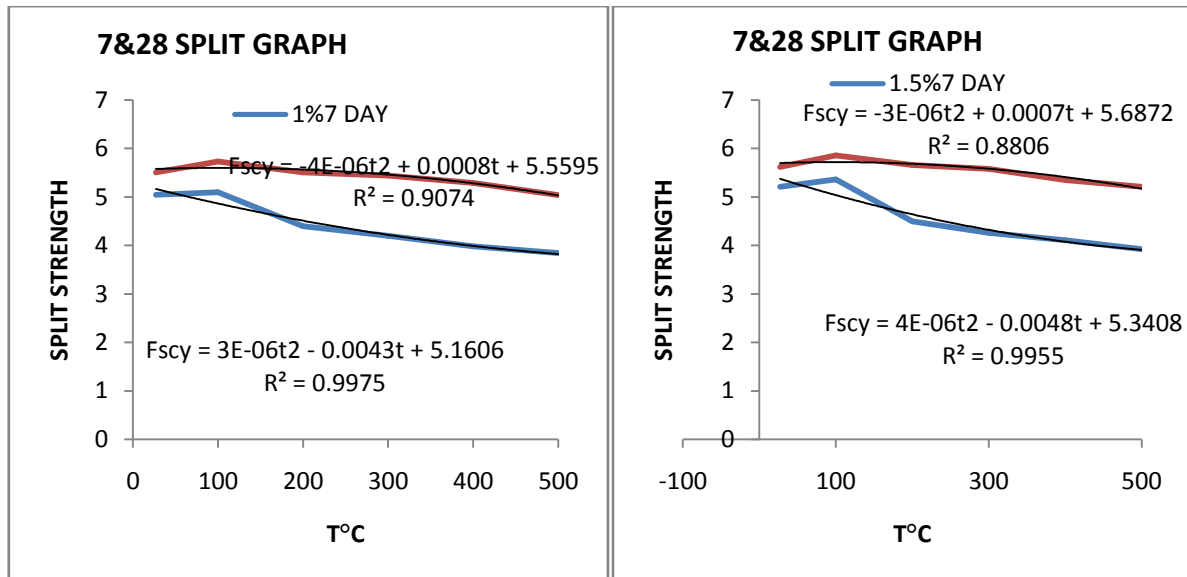
Fig.2. Graph .3Split Tensile strength 7days strength. **Graph .4** Split Tensile strength 28days strength



Graph 5

Graph 6

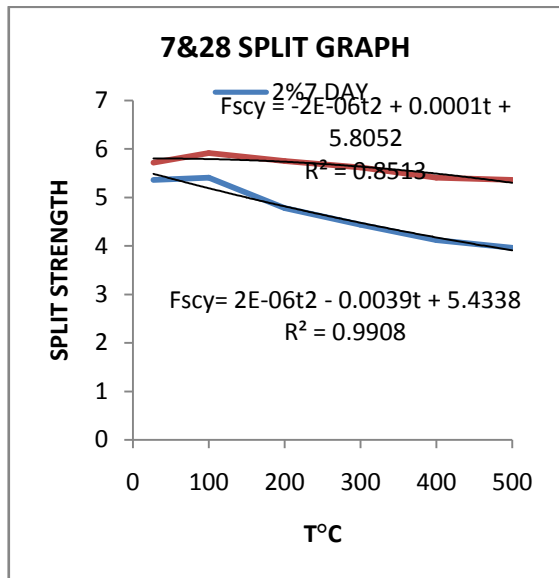
Fig.3. Graph .5 Split Tensile strength 7 & 28 days strength **Graph .6** Split Tensile strength 7 & 28 days strength



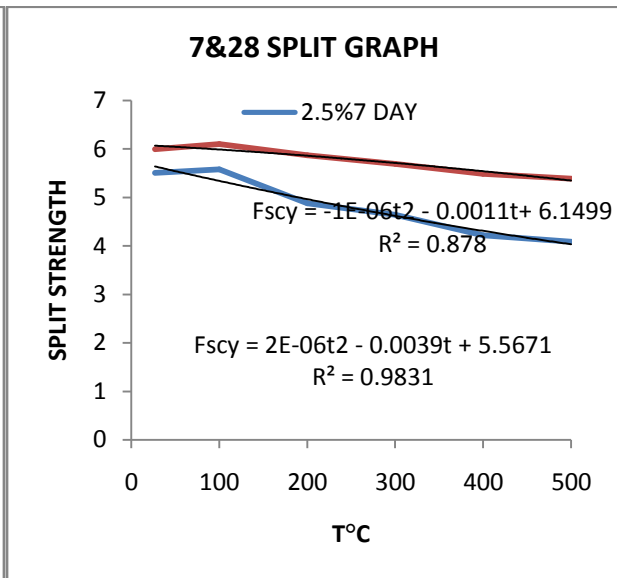
Graph 7

Graph 8

Fig.4. Graph .7 Split Tensile strength 7 & 28 days strength **Graph .8** Split Tensile strength 7 & 28 days strength

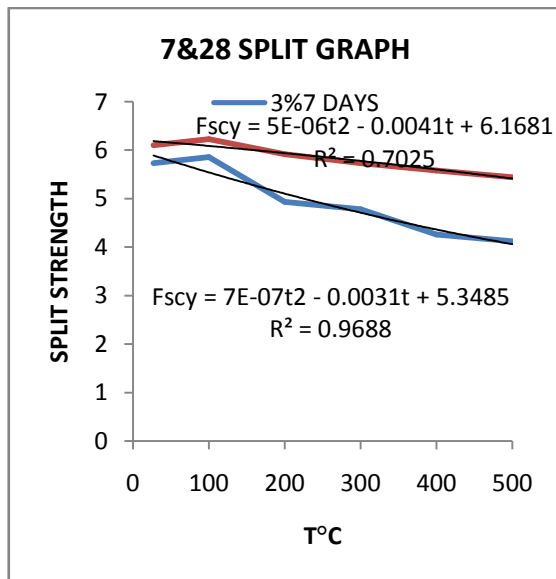


Graph 9

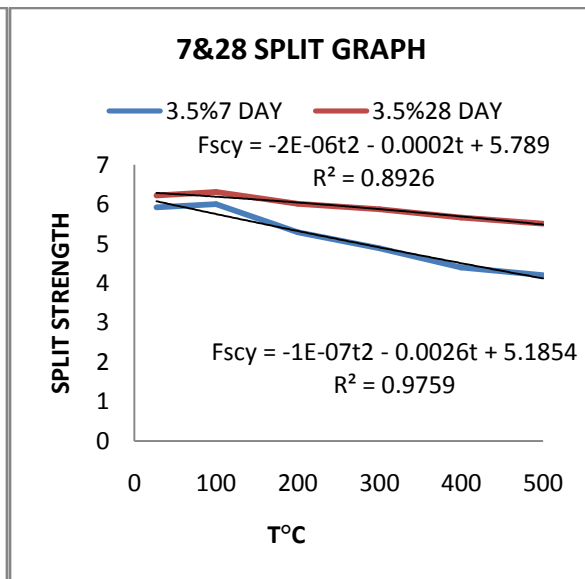


Graph 10

Fig. 5. Graph .9 Split Tensile strength 7 & 28 days strength Graph .10 Split Tensile strength 7 & 28 days strength

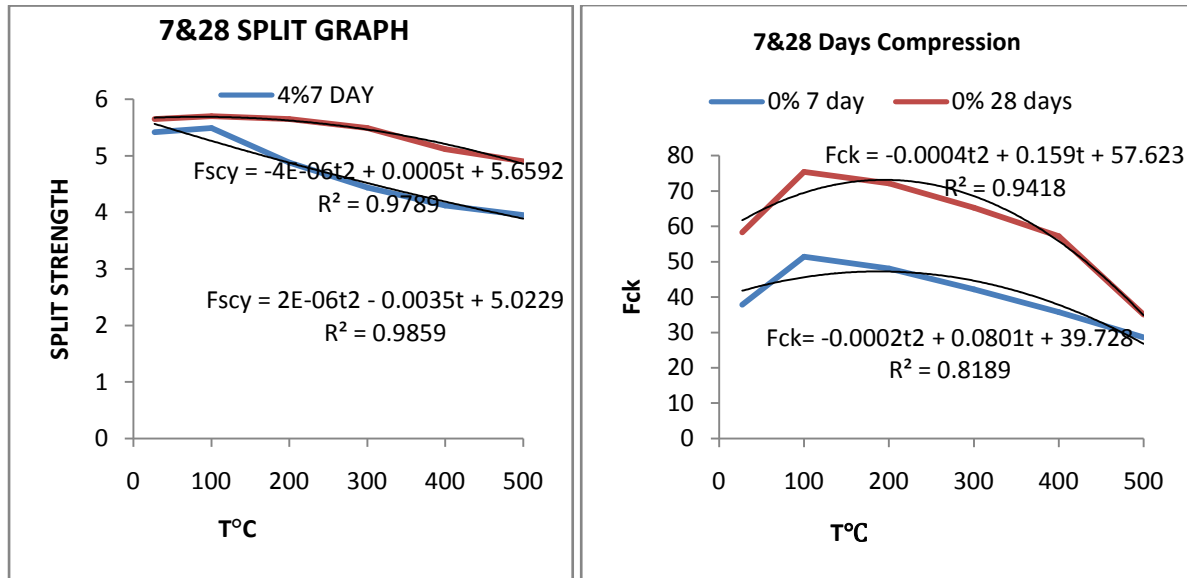


Graph 11



Graph 12

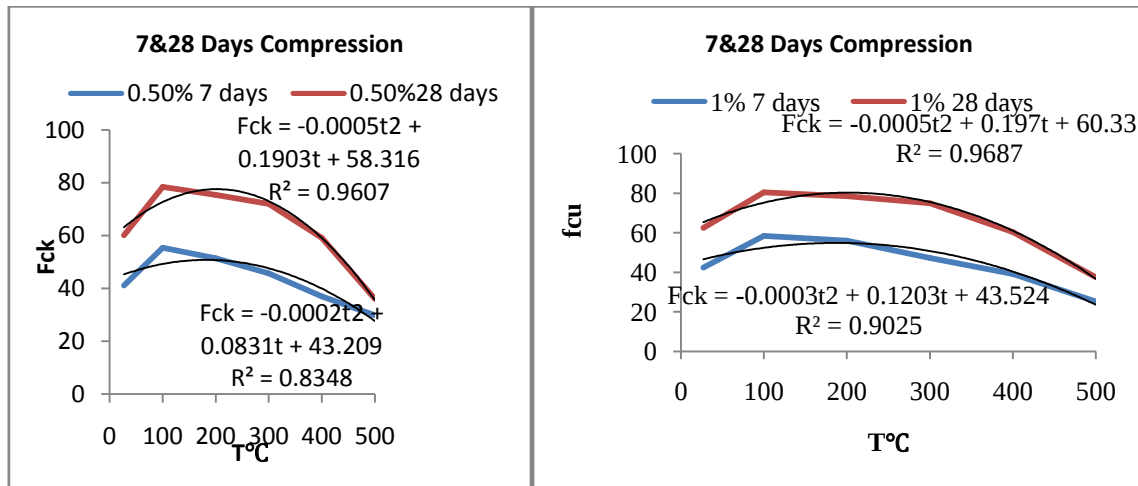
Fig. 6. Graph .11 Split Tensile strength 7 & 28 days strength Graph .12 Split Tensile strength 7 & 28 days strength



Graph 13

Graph 14

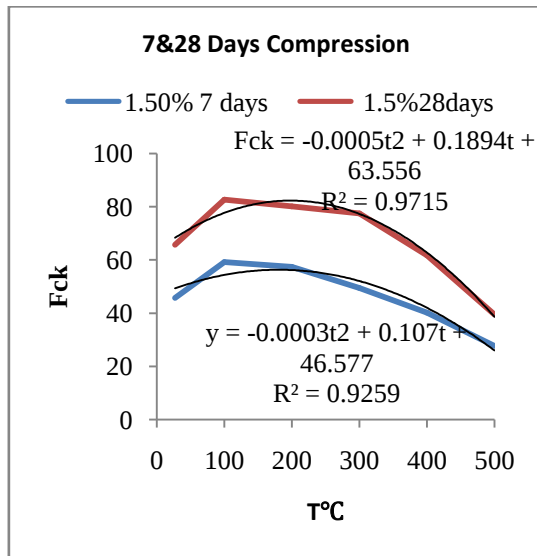
Fig.7. Graph.13 Split Tensile strength 7 & 28 days strength **Graph 14** Compressive strength 7 & 28 days strength



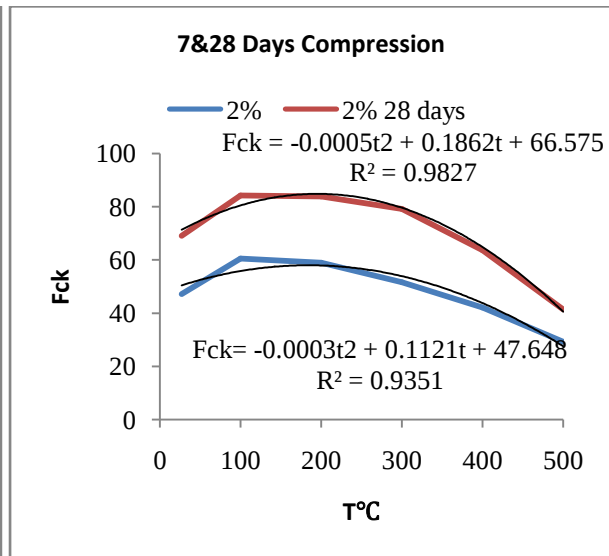
Graph 15

Graph 16

Fig.8. Graph .15 Compressive strength 7 & 28 days strength **Graph .16** Compressive strength 7 & 28 days strength.

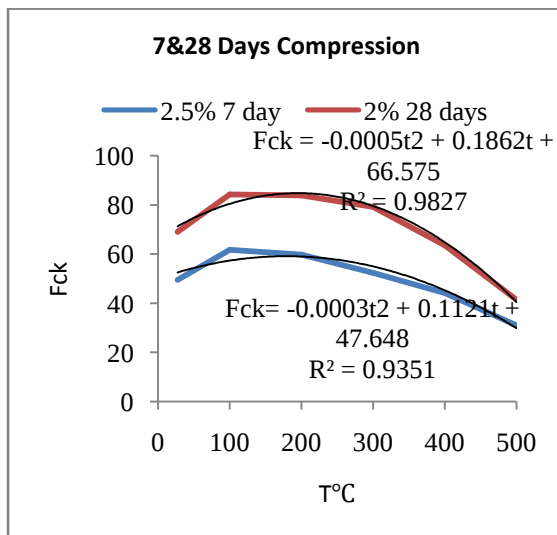


Graph 17

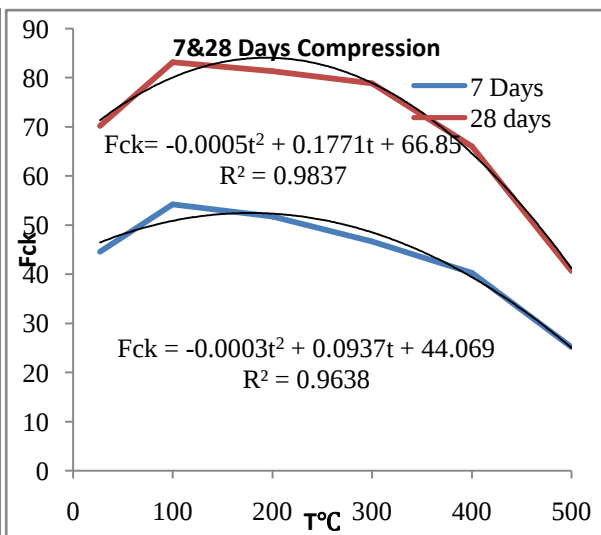


Graph 18

Fig.9. (Graph .17) Compressive strength 7 & 28 days strength (Graph .18) Compressive strength 7 & 28 days strength

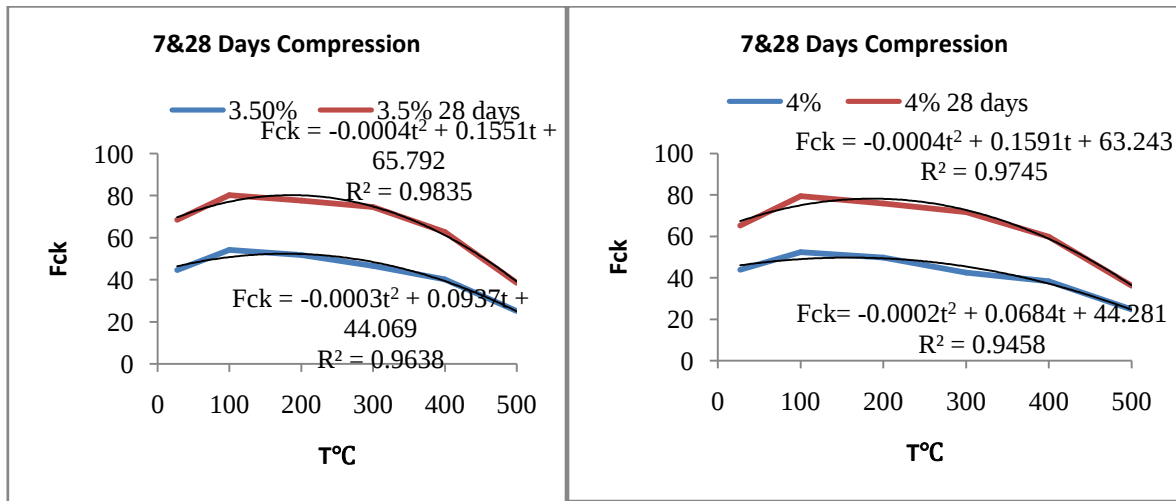


Graph 19



Graph 20

Fig.10. (Graph .19) Compressive strength 7 & 28 days strength (Graph .20) Compressive strength 7 & 28 days strength



Graph 21

Graph 22

Fig.11. (Graph .21) Compressive strength 7 & 28 days strength (Graph .22) Compressive strength 7 & 28 days strength

Table 3 Compressive strength by experimental and regression analysis

Sr.No	Mix Designation	Steel Fiber in %	Temperature in °C	Compressive strength, f_{cu} (Mpa)			
				7 Days		28 Days	
1	M ₀	0	27	37.82	41.74	58.27	65.53
2	M ₁		100	51.38	45.74	75.42	67.34
3	M ₂		200	48.04	47.75	72.13	67.01
4	M ₃		300	42.13	45.76	65.2	66.29
5	M ₄		400	35.73	39.77	57.2	65.41
6	M ₅		500	28.62	29.78	34.98	62.7
7	M ₆	0.5	27	41.11	46.287	60.13	67.951
8	M ₇		100	55.42	47.2	78.36	70.158
9	M ₈		200	51.33	46.948	75.33	69.814
10	M ₉		300	45.73	46.591	71.96	69.421
11	M ₁₀		400	37.02	46.011	59.11	67.818
12	M ₁₁		500	29.87	45.513	36.04	64.525
13	M ₁₂	1	27	42.4	48.085	62.4	70.676
14	M ₁₃		100	58.44	49.53	80.4	72.937
15	M ₁₄		200	55.91	49.312	78.4	72.702
16	M ₁₅		300	47.2	48.534	74.8	72.268
17	M ₁₆		400	39.16	47.775	60.31	70.392
18	M ₁₇		500	25.11	46.356	37.42	67.002
19	M ₁₈	1.5	27	45.78	50.847	65.73	73.845
20	M ₁₉		100	59.24	51.863	82.62	75.791
21	M ₂₀		200	57.42	51.732	80.13	75.522
22	M ₂₁		300	49.42	51.132	77.51	75.232

23	M ₂₂		400	40.22	50.395	61.73	73.342
24	M ₂₃		500	27.73	49.313	39.42	70.245
25	M ₂₄	2	27	47.2	52.151	69.02	76.654
26	M ₂₅		100	60.49	53.236	84.27	78.546
27	M ₂₆		200	58.93	53.096	83.82	78.285
28	M ₂₇		300	51.6	52.455	79.2	78.003
29	M ₂₈		400	42.13	51.671	63.6	76.164
30	M ₂₉		500	29.2	50.526	41.42	73.138
31	M ₃₀	2.5	27	49.47	52.151	71.42	76.654
32	M ₃₁		100	61.73	53.236	86.13	78.546
33	M ₃₂		200	59.82	53.096	85.33	78.285
34	M ₃₃		300	52.4	52.455	80.62	78.003
35	M ₃₄		400	44.22	51.671	68.44	76.164
36	M ₃₅		500	31.02	50.526	42.84	73.138
37	M ₃₆	3	27	46.22	47.759	70.13	76.811
38	M ₃₇		100	57.02	48.436	83.11	78.115
39	M ₃₈		200	54.8	48.303	81.33	77.946
40	M ₃₉		300	48.13	47.884	78.8	77.701
41	M ₄₀		400	41.42	47.435	65.96	76.356
42	M ₄₁		500	27.2	46.396	40.62	73.219
43	M ₄₂	3.5	27	44.53	47.647	68.53	74.542
44	M ₄₃		100	54.2	48.266	80.13	75.652
45	M ₄₄		200	51.73	48.113	77.6	75.419
46	M ₄₅		300	46.62	47.785	74.62	75.138
47	M ₄₆		400	40.22	47.352	62.71	73.945
48	M ₄₇		500	25.11	46.233	38.53	71.174
49	M ₄₈	4	27	43.82	46.894	65.11	71.906
50	M ₄₉		100	52.4	47.316	79.33	73.347
51	M ₅₀		200	49.73	47.188	75.82	73.006
52	M ₅₁		300	42.44	46.824	71.6	72.584
53	M ₅₂		400	38.22	46.603	59.82	71.329
54	M ₅₃		500	24.71	45.849	36.13	68.469

Table 4 Split Tensile strength by experimental and regression analysis

Sr.No	Mix Designation	Steel Fiber in %	Temperature in °C	Split Tensile strength, f_{sc} (Mpa)			
				Experimental Value	From Equation	Experimental Value	From Equation
				7 Days		28 Days	
1	M ₀	0	27	4.76	4.86067	5.35	5.39374
2	M ₁		100	4.88	4.86177	5.56	5.39395
3	M ₂		200	4.12	4.86355	5.39	5.39378
4	M ₃		300	3.93	4.86441	5.32	5.39371

5	M ₄	0.5	400	3.88	4.86463	5.15	5.39354
6	M ₅		500	3.74	4.86526	4.93	5.39332
7	M ₆		27	4.90	4.97989	5.42	5.47137
8	M ₇		100	4.93	4.98085	5.65	5.47157
9	M ₈		200	4.30	4.98222	5.44	5.47138
10	M ₉		300	4.12	4.98293	5.38	5.47133
11	M ₁₀	1	400	3.95	4.98359	5.22	5.47119
12	M ₁₁		500	3.81	4.98414	4.98	5.47097
13	M ₁₂		27	5.04	5.13891	5.51	5.5639
14	M ₁₃		100	5.10	4.98031	5.73	5.56407
15	M ₁₄		200	4.40	4.98183	5.51	5.5639
16	M ₁₅		300	4.20	4.98261	5.44	5.56384
17	M ₁₆	1.5	400	3.98	4.98347	5.29	5.56372
18	M ₁₇		500	3.84	4.98402	5.04	5.56352
19	M ₁₈		27	5.21	5.31578	5.62	5.69112
20	M ₁₉		100	5.36	5.31711	5.86	5.69129
21	M ₂₀		200	4.50	5.31919	5.66	5.69115
22	M ₂₁		300	4.26	5.32034	5.58	5.6911
23	M ₂₂	2	400	4.11	5.32107	5.35	5.69094
24	M ₂₃		500	3.92	5.32198	5.21	5.69084
25	M ₂₄		27	5.36	5.31578	5.72	5.69112
26	M ₂₅		100	5.41	5.31711	5.92	5.69129
27	M ₂₆		200	4.78	5.31919	5.75	5.69115
28	M ₂₇		300	4.44	5.32034	5.62	5.6911
29	M ₂₈	2.5	400	4.12	5.32107	5.41	5.69094
30	M ₂₉		500	3.96	5.32198	5.36	5.69084
31	M ₃₀		27	5.51	5.5456	6.00	6.1433
32	M ₃₁		100	5.58	5.5472	6.10	6.14304
33	M ₃₂		200	4.88	5.54806	5.87	6.14344
34	M ₃₃		300	4.64	5.549	5.69	6.14364
35	M ₃₄	3	400	4.22	5.55064	5.49	6.14386
36	M ₃₅		500	4.09	5.55115	5.39	6.14397
37	M ₃₆		27	5.73	5.33193	6.10	6.14381
38	M ₃₇		100	5.86	5.33328	6.23	6.14361
39	M ₃₈		200	4.93	5.33371	5.92	6.14463
40	M ₃₉		300	4.78	5.33427	5.73	6.14759
41	M ₄₀	3.5	400	4.26	5.33554	5.58	6.14603
42	M ₄₁		500	4.12	5.33613	5.44	6.1464
43	M ₄₂		27	5.92	5.17192	6.22	5.78785
44	M ₄₃		100	6.00	5.17289	6.31	5.78782
45	M ₄₄		200	5.29	5.17328	6.01	5.78787
46	M ₄₅		300	4.88	5.17373	5.87	5.78788
47	M ₄₆	4	400	4.40	5.17477	5.66	5.78795
48	M ₄₇		500	4.20	5.17536	5.51	5.78796
49	M ₄₈		27	5.42	5.17192	5.65	5.65636
50	M ₄₉		100	5.49	5.17289	5.70	5.65634
51	M ₅₀		200	4.88	5.17328	5.65	5.6564
52	M ₅₁		300	4.44	5.17373	5.49	5.65644
53	M ₅₂	4	400	4.12	5.17477	5.12	5.65663
54	M ₅₃		500	3.95	5.17536	4.90	5.65674

CONCLUSION

The specimens gave maximum percentage increase in compressive strength of steel

fiber reinforced concrete was with 2.5% of steel fiber and the specimens casted for split tensile strength gave the highest percentage increase at 3.5% of steel fiber. At 100°C temperature the strength increased abruptly and above 100°C the strength started getting reduces in both split tensile and compression testing. In addition to that the regression analysis for test results of split tensile strength and compressive strength was compared with experimental values and the result not much rehabilitated in both the strengths. As the temperature of the concrete raised beyond 27°C by placing in oven the strength of the concrete increased upto 100°C and get decrease till 500 °C gradually in compression and split tensile testing .

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