Global Journal of Engineering Science and Research Management

EFFECT OF ELEVATED TEMPERATURE ON COMPRESSIVE STRENGTH OF FIBER REINFORCED CONCRETE

Prashant shinkar*, Prof. Deepak kakade, Dr.A.P.Wadekar
* Civil Engineering, P.E.S College of Engineering, Aurangabad, India

DOI: 10.5281/zenodo.556386

KEYWORDS: steel fiber, elevated temperature, compressive.

ABSTRACT
This paper deals with the mechanical properties of concrete with steel fibers subjected to temperatures up to 500°C. Now a day concrete are being used extensively in the construction that might be subjected to elevated temperatures. The behavior of concrete structures at elevated temperatures is of significant importance in predicting the safety of structures in response to certain accidents or particular service conditions. Concrete mixes of M 50 have been designed along with steel fibers from 0.5-4% by weight of cement. Specimens were made and subjected at room temperature, 100, 200,300,400 and 500 °C. Compressive strength were determine and compare with value with regression analysis. This investigation developed some important data on the properties of concrete exposed to elevated temperatures up to 500°C.

INTRODUCTION
Concrete is widely used as construction material in world and it is very difficult to find another material of construction as versatile as concrete. Concrete is closely related to every human being and their day-to-day life. For making good or bad concrete it required same material. Hence controlling the properties at every stage of concrete plays important role in its quality and strength. The hardened concrete may also be considered as an artificial stone in which the voids of larger particles [coarse aggregate] are filled by smaller Particles [fine aggregate] and the voids of fine aggregate are filled with cement. Concrete is nothing but an artificial Stone resulting from the hardening of mixtures of cement, sand, coarse aggregate, water and sometimes mineral and chemical admixtures are also added to enhance properties of Concrete in fresh and hardened state. In a Concrete mix the cement and the water forms a paste called cement-water paste which in Addition to filling the voids of fine aggregate acts as a binder on hardening, thereby cementing the particles of the aggregate together in a compact mass. The use for concrete with Compressive strength higher than 50 MPa is widely accepted. The use of concrete in the construction industry has steadily increased over the past years, which leads to the design of smaller sections. This in turn reduces the dead weight, allowing longer spans Design of earthquake resistant structures. Such advantages often outweigh the higher Production cost of concrete associated with careful selection of ingredients, Mix proportioning, curing and quality control. Therefore high temperature in concrete is also taken into consideration.

MATERIALS AND METHODS
Steel Fibers
Steel fibers conforming to ASTM A 820 type -I are used for experimental work. Fibers are high tensile steel cold drawn wire and specially engineered for use in concrete. The length of fibers was 50mm with average aspect ratio 50 and appearance was bright in clean wire and fiber tensile strength 1000Mpa. Fiber specific gravity is 7.8 and modulus of elasticity of 200Gpa.

Experimental Program:
Ordinary Portland Cement confirming to IS 12269 were used with fine and coarse aggregates confirming to IS 383. The fineness modulus of sand was 2.803 and those of coarse aggregates were 7.52. The M-50 grade of concrete having mix proportions 1 : 1.472 : 3.043 : 0.35 i.e. Cement: Fine aggregate: Coarse aggregate (10mm and 20mm) with w/c ratio of 0.35 was used throughout experimental investigation.

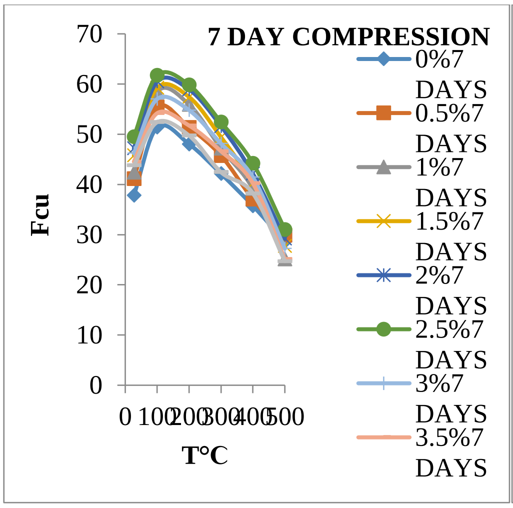
RESULTS AND DISCUSSION

Concrete is not a homogeneous material. Structurally concrete may be said that the particles of coarse aggregate are held together in a cement-sand mortar matrix. Even though 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. Hence the results and discussion may be combined into a common section or separately. The test results of compression and flexural are listed in the following tables and with the test results different graphs are plotted with a fiber interval of 0.5-4%.

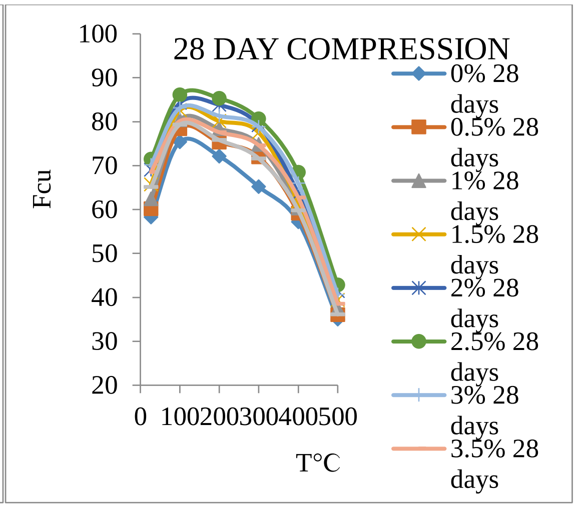
Table 1 Compressive strength 7 and 28 days

		7 and 28 days compressive strength										
		Temperature °C										
% steel fiber	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	65.20	35.73	57.20	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	42.40	62.40	58.44	80.4	55.91	78.4	47.20	74.80	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	47.20	69.02	60.49	84.27	58.93	83.82	51.60	79.20	42.13	63.60	29.2	41.42
2.5	49.47	71.42	61.73	86.13	59.82	85.33	52.40	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	78.80	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	71.60	38.22	59.82	24.71	36.13

Graph 1.Compression 7 day



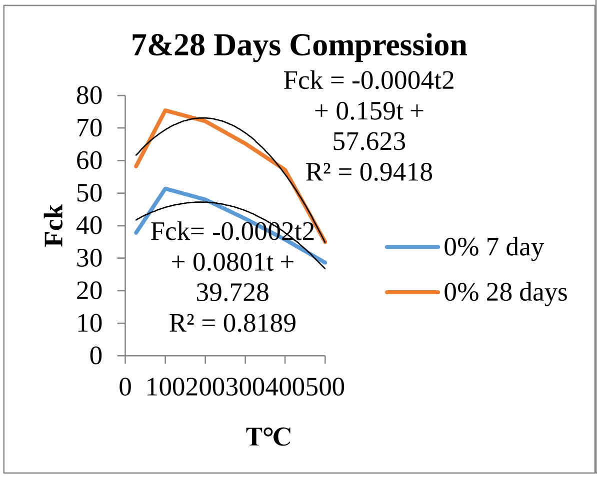
Graph 2.Compression 28 day

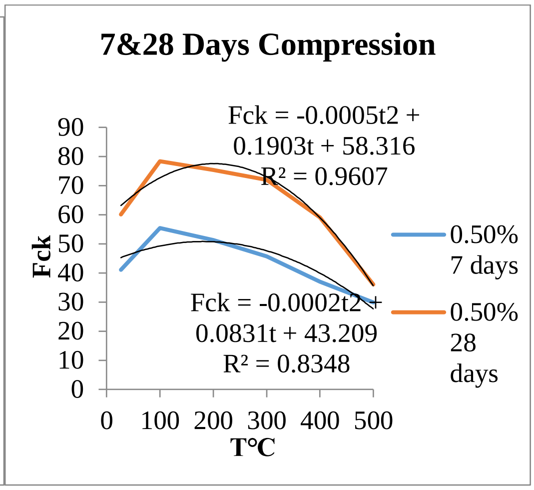


Graph 3.Compression 7& 28 days

Graph 4.Compression 7& 28 days

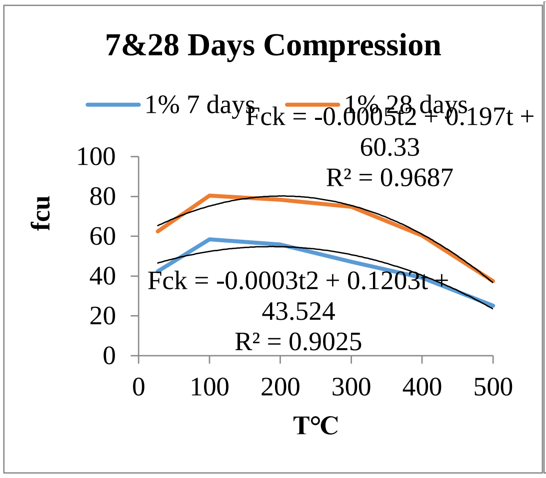
Global Journal of Engineering Science and Research Management

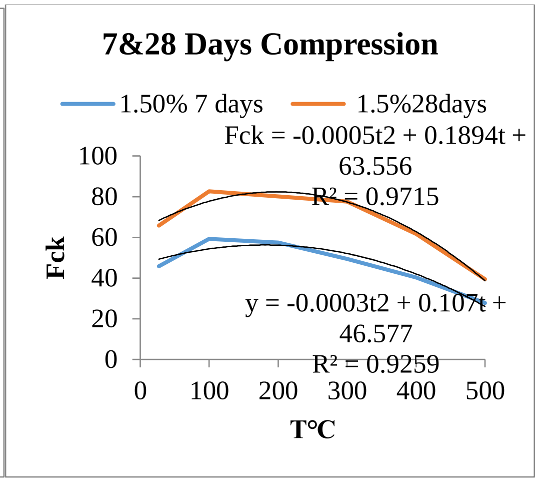




Graph 5.Compression 7& 28 days

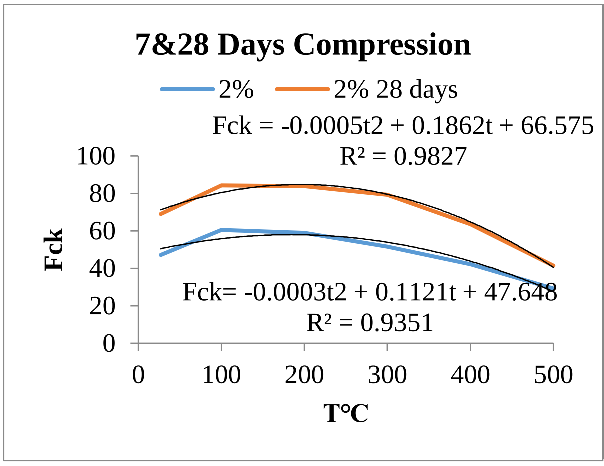
Graph 6.Compression 7& 28 days

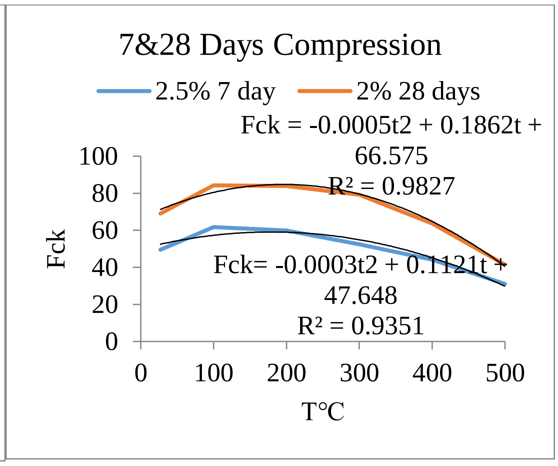




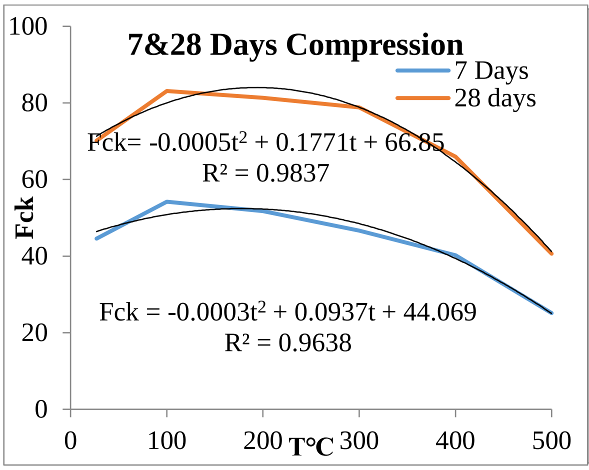
Graph 7.Compression 7& 28 days

Graph 8.Compression 7& 28 days

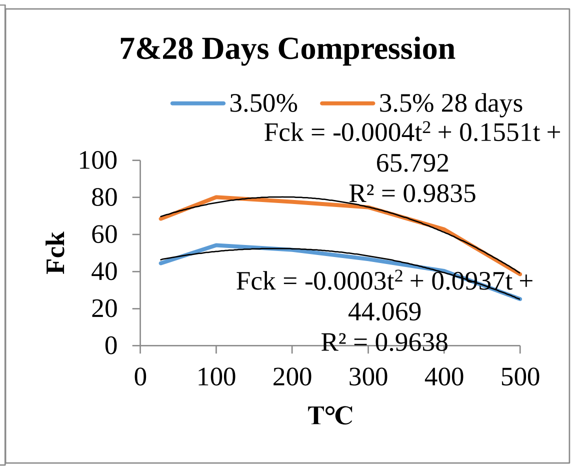




Graph 9.Compression 7& 28 days



Graph 10.Compression 7& 28 days



Graph 11.Compression 7& 28 days

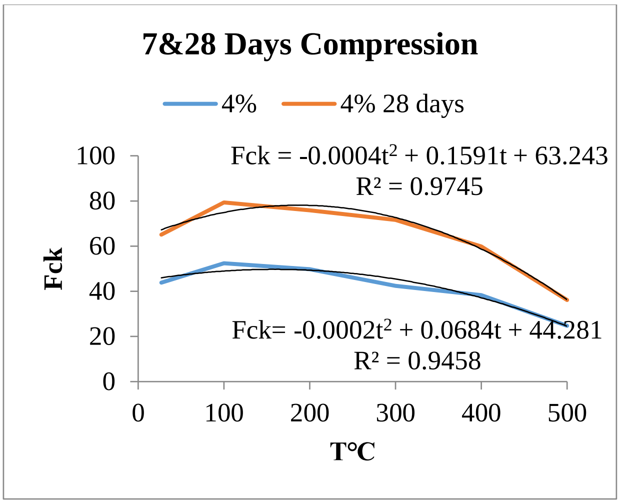


Table 3 Compressive strength by experimental and regression analysis

Sr.No	Mix Designation	T	Compressive strength, f_{cu} (Mpa)			
	0 % STEEL FIBER		Experimental Value	From Equation of graphs	Experimental Value	From Equation of graphs
			7 Days		28 Days	
1.00	M_0	27.00	37.82	41.74	58.27	65.53
2.00	M_1	100.00	51.38	45.74	75.42	67.34
3.00	M_2	200.00	48.04	47.75	72.13	67.01
4.00	M_3	300.00	42.13	45.76	65.20	66.29
5.00	M_4	400.00	35.73	39.77	57.20	65.41

6.00	M_5	500.00	28.62	29.78	34.98	62.70
0.50	**% STEEL FIBER**					
1.00	M_0	27.00	41.11	46.28723	60.13	67.95093
2.00	M_1	100.00	55.42	47.20013	78.36	70.15776
3.00	M_2	200.00	51.33	46.94757	75.33	69.81399
4.00	M_3	300.00	45.73	46.59092	71.96	69.42087
5.00	M_4	400.00	37.02	46.01127	59.11	67.81764
6.00	M_5	500.00	29.87	45.51275	36.04	64.52497
1.00						
1.00	M_0	27.00	42.40	48.08539	62.40	70.67592
2.00	M_1	100.00	58.44	49.52976	80.4	72.93672
3.00	M_2	200.00	55.91	49.31219	78.4	72.70152
4.00	M_3	300.00	47.20	48.53381	74.80	72.26808
5.00	M_4	400.00	39.16	47.7749	60.31	70.39242
6.00	M_5	500.00	25.11	46.35558	37.42	67.00161
1.50	**% STEEL FIBER**					
1.00	M_0	27.00	45.78	50.84672	65.73	73.84505
2.00	M_1	100.00	59.24	51.86287	82.62	75.7912
3.00	M_2	200.00	57.42	51.73182	80.13	75.52221
4.00	M_3	300.00	49.42	51.13224	77.51	75.23249
5.00	M_4	400.00	40.22	50.39525	61.73	73.34237
6.00	M_5	500.00	27.73	49.31342	39.42	70.24518
2.00	**% STEEL FIBER**					
1.00	M_0	27.00	47.20	52.1512	69.02	76.65371
2.00	M_1	100.00	60.49	53.23599	84.27	78.54581
3.00	M_2	200.00	58.93	53.09567	83.82	78.2848
4.00	M_3	300.00	51.60	52.45528	79.20	78.00346
5.00	M_4	400.00	42.13	51.67137	63.60	76.16383
6.00	M_5	500.00	29.2	50.52585	41.42	73.13804
2.50	**% STEEL FIBER**					
1.00	M_0	27.00	49.47	52.1512	71.42	76.65371
2.00	M_1	100.00	61.73	53.23599	86.13	78.54581
3.00	M_2	200.00	59.82	53.09567	85.33	78.2848
4.00	M_3	300.00	52.40	52.45528	80.62	78.00346
5.00	M_4	400.00	44.22	51.67137	68.44	76.16383
6.00	M_5	500.00	31.02	50.52585	42.84	73.13804
3.00	**% STEEL FIBER**					

1.00	M_0	27.00	46.22	47.75893	70.13	76.81091
2.00	M_1	100.00	57.02	48.43639	83.11	78.11514
3.00	M_2	200.00	54.8	48.30285	81.33	77.94626
4.00	M_3	300.00	48.13	47.88383	78.80	77.70076
5.00	M_4	400.00	41.42	47.43537	65.96	76.35616
6.00	M_5	500.00	27.2	46.39569	40.62	73.21881
3.50	**% STEEL FIBER**					
1.00	M_0	27.00	44.53	47.64658	68.53	74.54246
2.00	M_1	100.00	54.2	48.26625	80.13	75.65184
3.00	M_2	200.00	51.73	48.1133	77.6	75.41906
4.00	M_3	300.00	46.62	47.78527	74.62	75.1383
5.00	M_4	400.00	40.22	47.35232	62.71	73.9453
6.00	M_5	500.00	25.11	46.23265	38.53	71.17418
4.00	**% STEEL FIBER**					
1.00	M_0	27.00	43.82	46.89425	65.11	71.90628
2.00	M_1	100.00	52.4	47.31601	79.33	73.3471
3.00	M_2	200.00	49.73	47.18792	75.82	73.00649
4.00	M_3	300.00	42.44	46.82367	71.60	72.58394
5.00	M_4	400.00	38.22	46.60309	59.82	71.32899
6.00	M_5	500.00	24.71	45.84905	36.13	68.46913

CONCLUSION
The maximum percentage increase in compressive strength was with 2.5% of steel fiber. At 100°C temperature strength increased abruptly and above 100°C the strength started getting reduce. And by the regression analysis the test results was compared with experimental values and the result not much changed. As the temperature of the concrete raised beyond 27°C the strength of the concrete increased upto 100°C and get decrease till 500 °C.

REFERENCES

1. C.S. Poon, Z.H. Shui, L. Lam “Compressive behavior of fibre reinforced high-performance concrete subjected to elevated temperature” Cement and Concrete Research, vol. 34, pp2215-2222,2004.
2. Rafat Siddique, Deepinder Kaur, “Properties of concrete containing ground granulated blast furnace slag (GGBFS) at elevated temperatures”, Journal of Advanced Research, , vol. 3, pp 45-51,2012.
3. Li, Yuan, Xu and Dou “Effect of elevated temperature on the mechanical properties of high-volume GGBS concrete” Magazine of Concrete Research, vol. 66(24), pp1277-1285,2014.
4. Jingsi Huo, Bao Jin, Qi Yu, Yuanming He, and Yanzhi Liu “ Effect of Microstructure Variation on Damage Evolution of Concrete at High Temperate” ACI Material Journal, vol. 113, pp547-558, 2016.
5. Omer Arioz “Effects of elevated temperatures on properties of concrete” Fire Safety Journal, vol. 42, pp516-522, 2007.
6. Y.N. Chan, X. Luo, W.Sun “Compressive strength and pore structure of high-performance concrete after exposure to high temperature up to 800C” Cement and Concrete Research, 2000, vol. 30, pp247-251.
7. Sammy Yin Nin Chan, Xin Luo, Wei Sun “Effect of high temperature and cooling regimes on the compressive strength and pore properties of high performance concrete” Construction and Building Material, vol. 14, pp261-266,2000.

ISSN 2349-4506
Impact Factor: 2.785

Global Journal of Engineering Science and Research Management

8. How-Ji Chen, Shao-Siang Huang, Chao-Wei Tang, M.A. Malek, Lee-woen Ean "Effect of curing environments on strength, porosity and chloride ingress resistanceof blast furnace slag cement concretes: A construction site study" Construction and Building Materials, vol. 35, pp 1063-1070, 2012.
9. Bahar Demmirel, Oguzhan Kelestemur "Effect of elevated temperature on the mechanical properties of concrete produced with finely ground pumice and silica fume" Fire Safety Journal, vol. 45, pp 385-391, 2010.
10. Mohamed Heikal "Effect of temperature on the physico-mechanical and mineralogical properties of Homra pozzolanic cement pastes"Cement and Concrete Research, vol. 30, pp1835-1839, 2000.
11. Metin Husem "The effects of high temperature on compressive and flexural strengths of ordinary and high-performance Concrete" Fire Safety Journal, vol. 41, pp155-163, 2006,
12. H. Shehab EI-Din, Heba A. Mohamed "Effect of Temperature on Strength of Concrete Strengthening With CFRP" International Journal of Engineering Science and Innovating Technology, vol. 2(5) pp285-294, 2013.
13. I. Janotka and S. C. Mojumdar "Thermal Analysis At The Evaluation Of Concrete Damage By High Temperatures" Journal of Thermal Analysis and Calorimetry, vol. 81, pp197-203, 2005.
14. Qingtao Li, Zhuguo Li, Guanglin Yuan "Effects of elevated temperatures on properties of concrete containing groundgranulated blast furnace slag as cementitious material" Construction and Building Materials, vol. 35, pp 687-692, 2012.