**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:**

**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 | | | | | | | | | | |
| % steel fiber |  | Temperature °Ϲ | | | | | | | | | | |
| 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***

***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**  **0 % STEEL FIBER** | **T** | **Compressive strength, *f*cu (Mpa)** | | | |
|
| **Experimental Value** | **From Equation of graphs** | **Experimental Value** | **From Equation of graphs** |
|
| **7 Days** | | **28 Days** | |
| 1.00 | M0 | 27.00 | 37.82 | 41.74 | 58.27 | 65.53 |
| 2.00 | M1 | 100.00 | 51.38 | 45.74 | 75.42 | 67.34 |
| 3.00 | M2 | 200.00 | 48.04 | 47.75 | 72.13 | 67.01 |
| 4.00 | M3 | 300.00 | 42.13 | 45.76 | 65.20 | 66.29 |
| 5.00 | M4 | 400.00 | 35.73 | 39.77 | 57.20 | 65.41 |
| 6.00 | M5 | 500.00 | 28.62 | 29.78 | 34.98 | 62.70 |
| **0.50** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 41.11 | 46.28723 | 60.13 | 67.95093 |
| 2.00 | M1 | 100.00 | 55.42 | 47.20013 | 78.36 | 70.15776 |
| 3.00 | M2 | 200.00 | 51.33 | 46.94757 | 75.33 | 69.81399 |
| 4.00 | M3 | 300.00 | 45.73 | 46.59092 | 71.96 | 69.42087 |
| 5.00 | M4 | 400.00 | 37.02 | 46.01127 | 59.11 | 67.81764 |
| 6.00 | M5 | 500.00 | 29.87 | 45.51275 | 36.04 | 64.52497 |
| **1.00** |  |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 42.40 | 48.08539 | 62.40 | 70.67592 |
| 2.00 | M1 | 100.00 | 58.44 | 49.52976 | 80.4 | 72.93672 |
| 3.00 | M2 | 200.00 | 55.91 | 49.31219 | 78.4 | 72.70152 |
| 4.00 | M3 | 300.00 | 47.20 | 48.53381 | 74.80 | 72.26808 |
| 5.00 | M4 | 400.00 | 39.16 | 47.7749 | 60.31 | 70.39242 |
| 6.00 | M5 | 500.00 | 25.11 | 46.35558 | 37.42 | 67.00161 |
| **1.50** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 45.78 | 50.84672 | 65.73 | 73.84505 |
| 2.00 | M1 | 100.00 | 59.24 | 51.86287 | 82.62 | 75.7912 |
| 3.00 | M2 | 200.00 | 57.42 | 51.73182 | 80.13 | 75.52221 |
| 4.00 | M3 | 300.00 | 49.42 | 51.13224 | 77.51 | 75.23249 |
| 5.00 | M4 | 400.00 | 40.22 | 50.39525 | 61.73 | 73.34237 |
| 6.00 | M5 | 500.00 | 27.73 | 49.31342 | 39.42 | 70.24518 |
| **2.00** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 47.20 | 52.1512 | 69.02 | 76.65371 |
| 2.00 | M1 | 100.00 | 60.49 | 53.23599 | 84.27 | 78.54581 |
| 3.00 | M2 | 200.00 | 58.93 | 53.09567 | 83.82 | 78.2848 |
| 4.00 | M3 | 300.00 | 51.60 | 52.45528 | 79.20 | 78.00346 |
| 5.00 | M4 | 400.00 | 42.13 | 51.67137 | 63.60 | 76.16383 |
| 6.00 | M5 | 500.00 | 29.2 | 50.52585 | 41.42 | 73.13804 |
| **2.50** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 49.47 | 52.1512 | 71.42 | 76.65371 |
| 2.00 | M1 | 100.00 | 61.73 | 53.23599 | 86.13 | 78.54581 |
| 3.00 | M2 | 200.00 | 59.82 | 53.09567 | 85.33 | 78.2848 |
| 4.00 | M3 | 300.00 | 52.40 | 52.45528 | 80.62 | 78.00346 |
| 5.00 | M4 | 400.00 | 44.22 | 51.67137 | 68.44 | 76.16383 |
| 6.00 | M5 | 500.00 | 31.02 | 50.52585 | 42.84 | 73.13804 |
| **3.00** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 46.22 | 47.75893 | 70.13 | 76.81091 |
| 2.00 | M1 | 100.00 | 57.02 | 48.43639 | 83.11 | 78.11514 |
| 3.00 | M2 | 200.00 | 54.8 | 48.30285 | 81.33 | 77.94626 |
| 4.00 | M3 | 300.00 | 48.13 | 47.88383 | 78.80 | 77.70076 |
| 5.00 | M4 | 400.00 | 41.42 | 47.43537 | 65.96 | 76.35616 |
| 6.00 | M5 | 500.00 | 27.2 | 46.39569 | 40.62 | 73.21881 |
| **3.50** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 44.53 | 47.64658 | 68.53 | 74.54246 |
| 2.00 | M1 | 100.00 | 54.2 | 48.26625 | 80.13 | 75.65184 |
| 3.00 | M2 | 200.00 | 51.73 | 48.1133 | 77.6 | 75.41906 |
| 4.00 | M3 | 300.00 | 46.62 | 47.78527 | 74.62 | 75.1383 |
| 5.00 | M4 | 400.00 | 40.22 | 47.35232 | 62.71 | 73.9453 |
| 6.00 | M5 | 500.00 | 25.11 | 46.23265 | 38.53 | 71.17418 |
| **4.00** | **% STEEL FIBER** |  |  |  |  |  |
| 1.00 | M0 | 27.00 | 43.82 | 46.89425 | 65.11 | 71.90628 |
| 2.00 | M1 | 100.00 | 52.4 | 47.31601 | 79.33 | 73.3471 |
| 3.00 | M2 | 200.00 | 49.73 | 47.18792 | 75.82 | 73.00649 |
| 4.00 | M3 | 300.00 | 42.44 | 46.82367 | 71.60 | 72.58394 |
| 5.00 | M4 | 400.00 | 38.22 | 46.60309 | 59.82 | 71.32899 |
| 6.00 | M5 | 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°Ϲ temperature strength increased abruptly and above 100°Ϲ 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°Ϲ the strength of the concrete increased upto 100°Ϲ and get decrease till 500 °Ϲ.

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