LOSS OF STRENGTH IN CONCRETE DUE TO EXTENDED HEAT

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Abstract: The influence of elevated temperatures on mechanical properties of concrete is of very much important for fire resistance studies and also for understanding the behavior of containment vessels, chimneys, nuclear reactor, pressure vessels during service and ultimate conditions structures like storage tanks for crude oil, hot water, coal gasification, liquefaction vessels used in petrochemical industries, foundation for blast furnace and coke industries, furnace walls industrial chimney, air craft runway etc., will be subjected to elevated temperatures. So that the variation of compressive strength, performance are some of the important parameters to be investigated when concrete structures are subjected to temperatures.

Keywords: Elevated Temperature, Ordinary Conventional Concrete, Compressive Strength

INTRODUCTION

Concrete is a material often used in the construction of high rise buildings and special purpose. Concrete in case of unexpected fire, the concrete properties are changes after fire. Hence, it is important to understand the change in the concrete properties due to extreme temperature exposures. As the concrete used for special purpose, the risk of exposing it to high temperature also increases. To be able to predict the response of structure after exposure to high temperature, it is essential that the strength properties of concrete subjected to high temperatures be clearly understood. High temperature can cause the development of cracks. These cracks like any other cracks propagation may eventually cause loss of structural integrity and shorting of service life.

Physical and chemical response to fire

Most porous concretes contain a certain amount of liquid water. This begins to vaporise if the temperature exceeds 100°C, usually causing a build-up of pressure within the concrete. In practice, the boiling temperature range tends to extend from 100 to about 140°C due to the pressure effects. Beyond the moisture plateau, when the temperature reaches about 400°C, the calcium hydroxide in the cement will begin to dehydrate, generating more water vapour and also bringing about a significant reduction in the physical strength of the material. Other changes may occur in the aggregate at higher temperatures. For example quartzbased aggregates increase in volume, due to a mineral transformation, at about 575°C, whilst limestone aggregates will begin to decompose at about 800°C.

Testing Methods

Testing is done as per following IS code. The testing done for compressive strength of cubes were measured 28 curing as per IS: 516 – 1959 with both cases air dried and with effect of temperature varying from 50 0to 2000

METHODOLOGY

Flow Chart for Lab Work

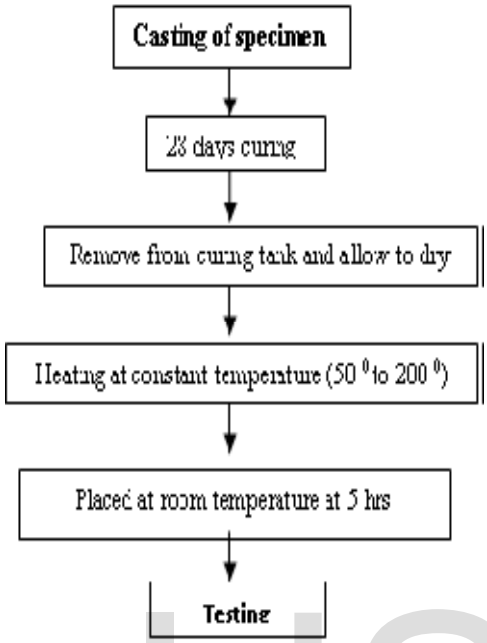

Figure 1

For each mix, a set of three standard cubes were casted to determine compressive strength of concrete at different constant temperature for duration one day and three days after 28 days of curing.

Cement: OPC
Size of Specimen: (150 X 150 X 150) mm
Area of Specimen: 0.0225 sq. m
Volume of specimen: 3.375 X 10^-3 cu. M
Temperatures: 50, 100, 150, 200 C
Curing age: 28 days

Figure 1

Temperatures Duration
After 28 days curing: One day.
The test is to be performed on Compression testing machine. The load at failure is recorded in kN.

Figure 2

Figure 3

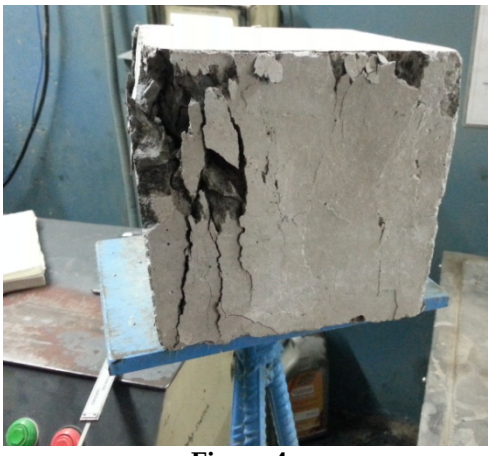

Figure 4

RESULTS AND DISCUSSIONS

The results are as follows

Table 1

Sr No.	Temper-ature in °C	Compressive Strength (Normal Concrete) in N/mm2(Day 1)
1	50	35.84
2	100	40.76
3	150	42.66
4	200	42.96

Table 2

Sr No.	Temper-ature in °C	Compressive Strength (Concrete with admixture and fly ash) in N/mm2(Day 1)
1	50	29.1
2	100	31.7
3	150	42.8
4	200	41.7

It is clear that the compressive strength of concrete decreases at elevated temperature except around 150 °C where a considerable increase in the compressive strength is observed. This is due to the evaporation of the free water content which accelerates the hydration and hence increases the compressive strength till 150 °C. For temperatures higher than
150 °C, the compressive Strength concrete starts to decrease. This decrease is attributed to the fact that chemically-bound water starts to disintegrate and evaporate at this stage.

The compressive strength in both cases of concrete with 24 hours (one day) of temperature after 28 days curing at 50°C,100°C, 150°C, 200°C was 35.84MPa, 40.74MPa, 42.66MPa, 42.96 MPa.

And 29.1MPa, 31.7MPa, 42.8MPa, 41.7MPa.

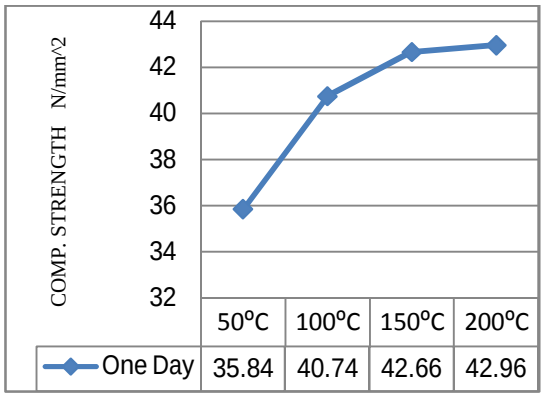

Figure 5

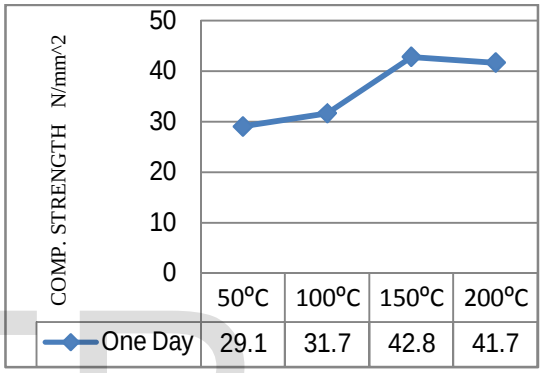

Figure 6

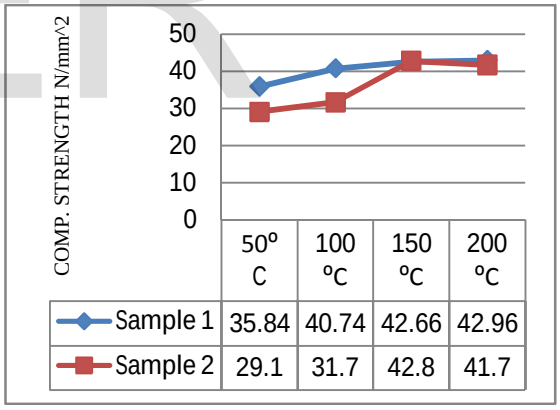

Figure 7

CONCLUSIONS

Based on the results presented above, the following conclusions can be drawn:

- In sample 2 the compressive strength was found to increase after 24 hours of exposure to an elevated temperature up to 150 ºC after that the compressive strength of concrete decreases with increasing temperature.
- The peak value in the ratio of the compressive strength at high temperature is observed around 150 ºC. This peak value obtained due to the evaporation of free water inside the concrete.
- Different methods of curing irrespective of types of concretes made with different admixtures might be caused the reduction in the mechanical properties due to Extended Heat.
- The replacement of cement by natural and chemical admixtures, fly ash, finely Palm Oil Fuel Ash, Rice Husk Ash would be caused the decrease in the compressive strength due to Extended Heat.

Scope of Future Investigation

The present work has good scope for future research. Some of the research areas are as follows:

- Investigation of ductility parameters characteristics and potential application in seismic design and construction.
- Behaviour under creep and shrinkage.
- To study the behaviour of mechanical and physical properties at low temperatures also.
- Same parameters with recycled aggregates.
- The behavior of concrete in fire is not well characterized at present, and further research is required in almost every aspect of this field. The response of concrete material to heating is fundamentally complex; for example degradation in physical properties of concrete varies strongly depending upon the details of concrete mix, including the moisture content, and relevant environmental parameters, such as the maximum fire temperature and fire duration. These changes are generally irreversible. Systematic studies are required on the effect of different heating condition of concrete.

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