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"VARIATION IN STRENGTH OF CONCRETE SUBJECTED TO HIGH TEMPERATURE"

H. G. MUNDLE

Lecturer of Civil Engineering, Shri Data Meghe Polytechnic, Nagpur, Maharashtra, India

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.

The Objectives and Scope of Present Study are

The objectives of this topic are to investigate the effects of high temperatures on concrete performance. High temperature resistance is defined as the ability of a structural element to withstand its load-bearing function under high temperature condition.

The concrete behavior at high temperature is of concern in predicting the safety of building and construction in response to certain accidents or particular service conditions. The behavior of concrete with respect to high temperature where tested on groups of specimens to identical testing condition.

EXPERIMENTAL PROGRAMME

A baseline is needed to establish an experimental design to conduct testing and observations for future development and research. All the baseline concrete material used in this study is shown in table 1.

Table 1: Experimental Baseline

S. N.	Baseline Element	Type
1	Cement	Ultra-tech 53 grade PPC.
2	Sand	Standard Sand and Vainganga Sand.
3	Coarse Aggregate	20mm- 4.75 mm size course aggregate.

Ordinary Portland Cement

OPC 43 grade cement is used for this whole experimental study. The physical test results on OPC are as follows.

- Normal consistency = 22%
- Initial Setting time = 30 min.
- Final Setting Time = 10 hrs.
- Specific Gravity = 3.15

Test on Concrete

An M25 mix is designed as per guidelines in IS 10262, 1982 based on the preliminary studies conducted in the constituent materials. Tests on fresh concrete are obtained as follows.

- Slump Test=65mm
- Vee-Bee = 15sec.
- Compaction factor =0.95
- Flow Test =79 %.

Mixture Proportioning

The mixture proportioning was done according the Indian Standard Recommended Method IS 10262- 1982. The target mean strength was 32.1 Mpa for the OPC control mixture, the total binder content was 435.45 kg/m, fine aggregate is taken 476kg/m and if any, the influence of plasticizer on the properties of hardened concrete coarse aggregate is taken 1242.62kg/m the water to binder ratio was kept constant as 0.44, cube moulds were used for casting.

Compaction of concrete in three layers with 25 strokes of 16 mm rod was carried out for each layer. The concrete was left in the mould and allowed to set for 24 hours before the cubes were de molded and placed in curing tank. The concrete cubes were cured in the tank for 28days.

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 ^{0}to 200^{0}.

Flow Chart for Lab Work

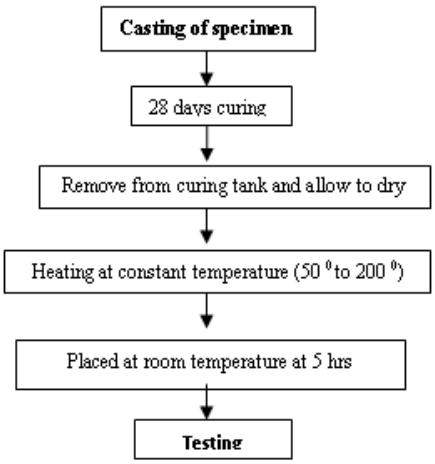


Figure 1

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: PPC

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: 50,100,150,200^0 C

Curing age: 28 days

Temperatures Duration

After 28 days curing: One day & three day.

The test is to be performed on Compression testing machine. The load at failure is recorded in kN.

RESULTS AND DISCUSSIONS

The results are as follows

Table 2: Compressive Strength Result

Sr No.	Temperature in °C	Compressive Strength in N/mm^2(Day 1)	Compressive Strength in N/mm^2 (Day 3)
1	50	35.84	38.51
2	100	40.74	41.63
3	150	42.66	45.32
4	200	42.96	40.14

The observed values of the compressive strength for the concrete mix (M25) at elevated temperatures are shown in figure 3. Also, the average percentage weight loss of concrete at elevated temperatures to that at normal (air dried) is shown in figure 2.

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 of concrete with 24 hours (one day) & 72 hours (three 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 (one day).

For three days 38.51MPa,41.63MPa,45.32MPa,40.14 Mpa respectively, while the compressive strength of normal air dried specimen with 24 hours (one day) & 72 hours (three day) after 28 days curing is 34.95MPa, 35.558MPa, 41.48MPa, 37.88 MPa (one day) and 36.3MPa, 37.47MPa, 40.16MPa,41.03 MPa (three day) respectively.

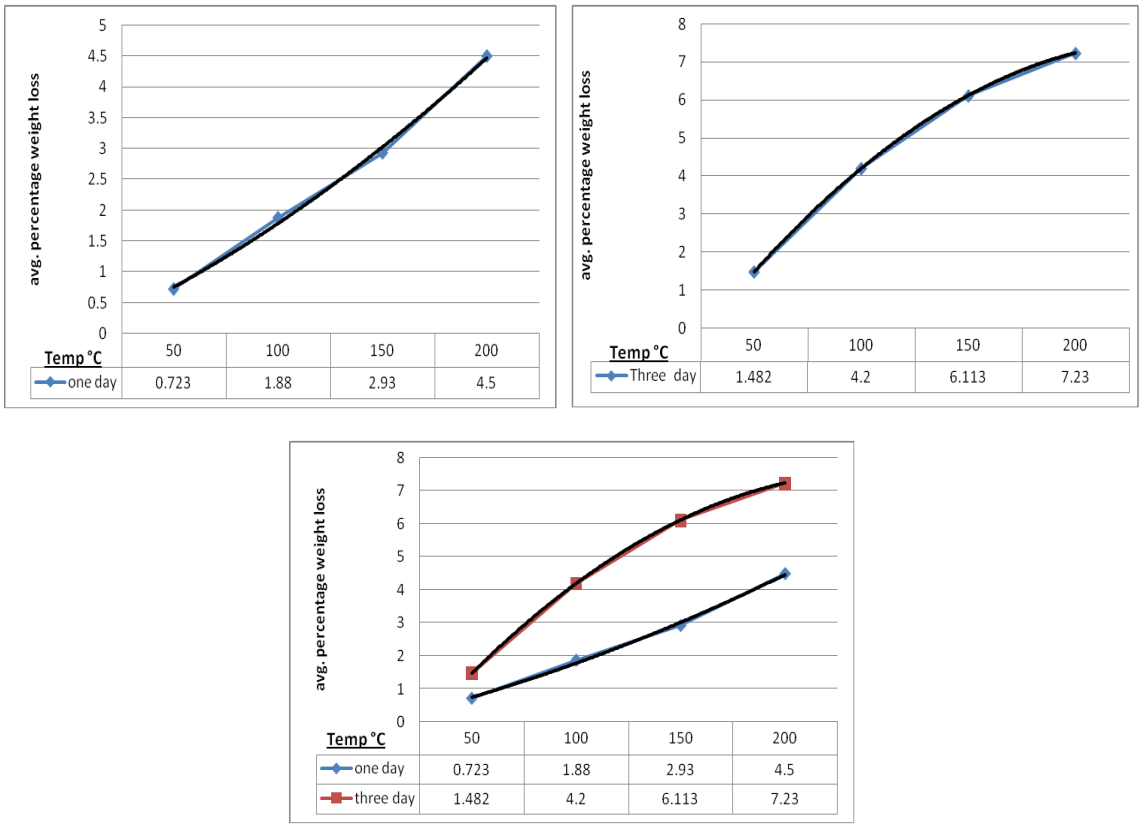
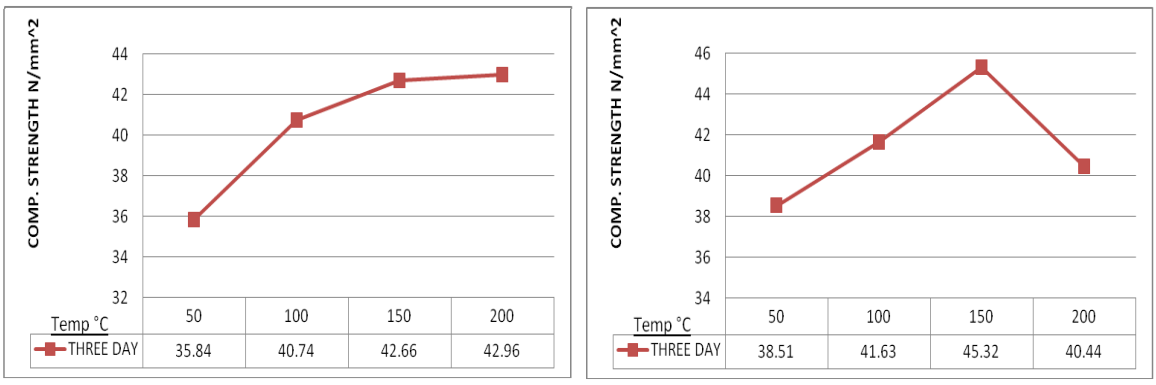


Figure 2: Weight Loss Due to Temperature



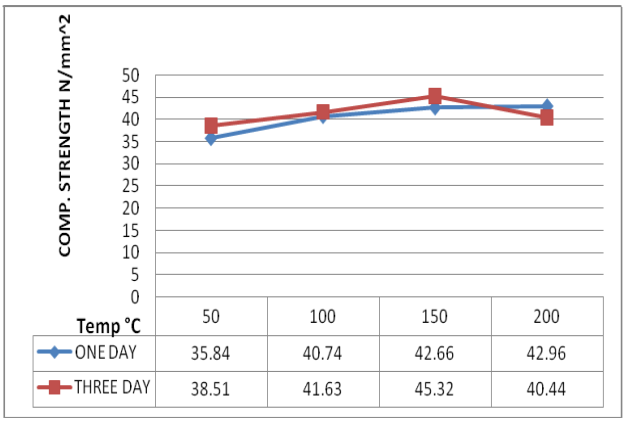


Figure 3: Effect of Temperature on Concrete Strength

CONCLUSIONS

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

- The compressive strength was found to increase after 72 hours of exposure to an elevated temperature up to 150^0 C 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 150^0 C.
- This peak value obtained due to the evaporation of free water inside the concrete.
- The compressive strength was found to increase after 24 hours of exposure to an elevated temperature up to 200^0 C after that compressive strength of concrete will be decreases with increasing temperature after the peak point.

SCOPE FOR FUTURE WORK

- Conduct further studies to determine variation in strength subjected to high temperature (above 200°C) in concrete for one day after 28 days curing.
- 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.
- Conduct further studies to determine the compressive strength of concrete with silica fume with the effect of different temperature.

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