Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Technophilia-2018.

Volume 5, Special Issue 04, Feb.-2018 (UGC Approved)

A paper on compressive strength of concrete subjected to elevated temperature

Miss. D. S. Yewale[1], Mr. D. B. Pawar[2] Miss. Pallavi Sathe[3]

[1]*Civil Engineering Department, Jaihind Polytechnic, Kuran.*
[2] *Civil Engineering Department, Sou. Venutai Chavhan polytechnic, Pune*
[3]*Civil Engineering. Department, Sinhgad college of engineering, Vadgaon, Pune*

Abstract - *The structural behaviour of concrete subjected to elevated temperature due to fire is governed by range of temperature, duration of temperature, and material properties of concrete. The reduction in compressive strength ,crack formation, spelling phenomenon, adverse effect on reinforcement etc. are some of the effects on concrete due to elevated temperature. The mechanical properties of concrete, physical and chemical responses of constituents of concrete variation in thermal gradients during the fire and post fire cooling operations are responsible to govern the structural behaviour of concrete. Very less study is reported indicating the comparison of effect of elevated temperature, the method of cooling for different types of concrete such as concrete with M20.The investigations were carried out on the compressive behavior of M20 .Cubes of 150mm X 150mm X 150mm size were cast using M20 grade of concrete. Specimens were heated in oven at temperature of 150o C and 250o C for 2 hours. Some of specimen were tested were allowed to cool on their own by natural cooling while, remaining were quenched in water to provide maximum thermal shock by jet cooling. This specimen was tested for compression in compression testing machine (C.T.M) up to first crack loading. Effect of this on compressive strength was compared with control specimen. The weight loss increases as the temperature increases and percentage weight loss was in natural cooling. The percentage loss in compressive strength was more in case of natural cooling as temperature cooling as temperature increases. In meeting this objective the effects of elevated temperatures on the properties of ordinary Portland cement concrete constituent materials and concretes are summarized. The effects of elevated temperature on high-strength concrete materials are noted and their performance compared to normal strength concretes. A review of concrete materials for elevated temperature service is presented. Nuclear power plant and general civil engineering design codes are described. Design considerations and analytical techniques for evaluating the response of reinforced concrete structures to elevated-temperature conditions are presented. Pertinent studies in which reinforced structural elements were subjected to elevated temperatures are described.*

Keywords- s*tructural behaviour, compression testing machine*

I. INTRODUCTION

After the 9-11 attack on the world trade center, 26/11 attacks in Mumbai; fire incident in Mantralaya of Maharashtra, India etc., interest in the design of structure subjected to the fire has greatly increased. Some engineer have promoted the use of advance analytical models to determine the fire growth within a compartment and have use finite element models of structural components to determine the temperatures within a component by heat transfer analysis .Following the calculation of the temperature , the mechanical properties at various time during the period of the fire must be determine. It is an important factor for the structural engineers to study the behavior of structures in fire and to provide simplified techniques which can be used successfully for many years to design structure to resist the effect of severe fires. One of the advantages of concrete over other building materials in its inherent fire resistive properties; however, concrete structures must still be design for fire effects. Structural components still must be able to withstand dead load and live loads without collapse even though rise in temperature causes decrease in a strength and modulus of elasticity for concrete and steel reinforcement. In addition, fully developed fires causes expansion of structural components and the resulting stresses and strain must be resisted. A relatively new method for determining fire exposure used by fire protection engineers is to first calculate the first load density in a compartment. Then, based on ventilation conditions and an assume source of combustion determine the compartment temperature at various times. Another factor considered in the analysis is the effect of active fire protection systems example sprinklers or fire brigades on the growth of fire the size and timing of the fire growth determined by fire analysis is sensitive to changes in the fuel load overtime and changing ventilation condition during the fire. This method of fire analysis requires special software and extensive training and is used only in very used large on unusual buildings.

II. TYPES OF CONCRETE

High performance concrete (HPC) exceeds the properties and constructability of normal concrete. Normal and special materials are used to make specially materials are used to make these specially designed concrete that must meet a combination of performance requirements. Special mixing, placing and curing practices may be needed to produce and handle high performance concrete. High performance concrete characteristic are developed for particular applications and environments; some of property that may be required include: High modulus of elasticity.

1. High abrasion resistance.
2. High durability and severe environments.
3. Low permeability and diffusion.
4. Resistance to chemical attack.
5. High resistance to frost and deicer scaling damage.
6. Toughness and impact resistance.
7. Volume stability.
8. Ease of placement.
9. Compaction without segregation.

III. MATERIALS AND METHODS

There are various methods strengthening of structures. Among them the newly and novel methods are use. In this study, test are performed to evaluated the percentage increase the strength of cube due to elevated temperature this methodology is divided into different phases

Table 1: Different phases of work

Sr. no.	Phase	Work
1	I	Testing and procurement of materials
2	II	Testing of concrete properties(mix design)
3	III	Preparation of molds, casting, and curing of specimens
4	IV	Subjected specimen to elevated temperature
5	V	Testing and resulting of specimens

.

Testing and procurement of materials

In this phase the type of material, quality of material require, properties of material for the work are carried out in this phase. The constituents of concrete via cement, fine aggregate, coarse aggregate are determine. They are discussed below.

Cement

Ordinary Portland cement of grade 43 confirming to IS 12269-1987is use in the entire experimental programmed. The preliminary test was conducted on this cement for determination of its physical properties. When tested for fineness by sieve analysis method. When tested by 'Le hoteliers' method and autoclave method test describe in IS 4031-1968, an aerated cement shall not have an expansion 10mm and 0.8%, respectively.

The setting time of cement in minutes- not less than 30

The final setting time of cement in minutes- not more than 600

Tests on cement= The cement used in this experimental work is "OPC 43 grade cement". All properties of cement are tested by referring IS 12269-1987.

Fineness of cement is = 0.04%

IV. MIX DESIGN FOR M20 GRADE OF CONVENTIONAL CONCRETE

Assumptions:

Compressive strength required for 28 days = 20 MPa
Maximum size of aggregate = 20 mm (angular)
Degree of quality control = Good
Type of exposure = Mild

Data

Specific Gravity of Cement = 3.15
Specific Gravity of Fine Aggregate = 2.86
Specific Gravity of Coarse Aggregate = 2.88
Water Absorption of Coarse Aggregate = 1.3%
Water Absorption of fine Aggregate = 0.64%
Slum required = 50 – 100 mm
Free moisture in Sand = 0.02%

Calculations:

1) **Target Mean Strength:**

$f_t = f_{ck} + K \times S$ (as per IS 10262)
$= 20 + 4.6 \times 1.65$
$= 26.60$ N/mm2

2) **Selection of Water Cement Ratio:**

Free water cement ratio for target mean strength = 0.55

3) Selection of Water and Sand Content

For 20mm nominal maximum size aggregate and sand confirming to grading zone II, water content per cubic meter of concrete = 186 kg and sand content as percentage of total aggregate by absolute volume = 35%

For changes in values in water cement ratios, compacting factor and sand belonging to zone III, the following adjustment is required.

Table 2. Table for Adjustment in Mix Proportion

Change in Condition	**Adjustment required in**	
	Water Content (%)	**Percentage sand in total aggregate**
For decrease in water cement ratio by(0.6-0.5) this is 0.10	0	-2.0
For increase in compacting factor(0.90-0.80) that is 0.10	+3	0
For sand confirming to zone III of table 4 of IS 383- 1970	0	-1.5
Total	+3	-3.5

Therefore, required sand content as percentage of total aggregate is given by

Absolute Volume = 35-3.5

= 31.5%

Required water content = 186+ 186 x 3/100

w/c (0.5) = 191.6 lit/m3

4) Determination of Cement Content:

Water cement ratio = 0.5

Water = 191.6 litres

Cement = 383 kg/m3

This cement content is adequate for mild exposure condition.

5) Determination of Coarse and Fine Aggregate Content:

Entrapped air = 2%

Concrete volume = 1.00-0.02 = 0.98m3

$$0.98 = 191.6+\frac{383}{3.15}+\frac{1}{0.315}\times\frac{Fa}{2.86}\times\frac{1}{1000}$$

$$0.98 = 191.6+\frac{383}{3.15}+\frac{1}{(1-0.315)}\times\frac{Ca}{2.88}\times\frac{1}{1000}$$

Fa = 600.73 kg/m3

Ca = 1306.35 kg/m3

Therefore final mix proportion

Table 3. Table for Mix Proportion.

On basis of	Water	Cement	Fine Aggregate	Coarse Aggregate
Mass	191.6 lit	383 kg	600.73 kg	1306 kg
Ratio	0.5	1.0	1.5	3.0
Per Bag	24.35 lit	50 kg	72.42 kg	153.73 kg

V. CONCLUSION

As a temperature goes on increase the strength loss of concrete also increase. Percentage weight loss of concrete increases with increase in temperature. The weight loss in case of natural cooling is more as compared to water jet cooling. The compressive strength loss of specimen for water jet cooling are more than natural cooling which is at about 20% and is increase with increase in temperature. Compressive strength of concrete is affected by method of cooling i.e natural cooling and water jet cooling. The compressive strength for normal concrete in case water jet cooling reduces as temperature increases and in case of natural cooling compressive strength reduces as temperature increases but as compared to water jet cooling it reduces more. Percentage weight loss of concrete which is more in a natural cooling as compare with water jet cooling for a same temperature. Percentage weight loss of concrete for natural cooling as well as water jet cooling increase further increase in temperature. The strength loss and weight loss after heating at high temperature is less in case of concrete using fly ash as compared to normal concrete. The above work shows that elevated temperature affects weight loss as well as compressive strength loss of concrete his strength can be regained by using fly ash as a admixture to the structural member subjected to elevated temperature.

REFERENCES

[1] Kode Venkata Ramesh, D.Jagath Kumari, M.Potha raju, and D. Shree Ramachandra Murty studied "Behaviour of HVFA columns subjected to elevated temperature" The Indian concrete journal, May ,pp 43-50.(2012)

[2] V. S. Ramachandran, R. F. Feldman, and J. J. Beaudoin, Concrete Science—A Treatise on Current Research, Hey and Son, London, (1981).

[3] 3. G. A. Khoury, "Performance of Heated Concrete—Mechanical Properties," Contract NUC/56/3604A with Nuclear Installations Inspectorate, Imperial College, London, August 1996.

[4] U. Schneider, Behaviour of Concrete at High Temperature, HEFT 337, Deutscher Ausschuss für Stahlbeton, Wilhelm Ernst & Sohn, Munich, Germany, 1982.

[5] U. Schneider, C. Diererichs, and C. Ehm, "Effect of Temperature on Steel and Concrete for PCRV's," Nuclear Engineering and Design 67, 245–258 (1981).

[6] Z. P. Bazant et al., Normal and Refractory Concretes for LMFBR Applications—Vol. 1, Review of Literature on High-Temperature Behavior of Portland cement and Refractory Concretes, EPRI Report NP-2437, Northwestern University and Portland Cement Association, Chicago, Illinois, June 1982.

[7] N. V. Waubke, "On One Physical Aspect of Strength Loss of Portland Cement Concretes at Temperatures up to 1000°C," in Brandverhalten von Bauteilen, Schriftenreisse der Deutschen Forschungsgemeinschaft, Heft 2, Technical Universität Braunschweig, Germany, November 1973.

[8] T. Z. Harmathy and L. W. Allen, "Thermal Properties of Selected Masonry Unit Concretes," J. American Concrete Institute 70, 132–142 (1973).