The Residual Strength for Different Shaped High Strength Concrete Specimens at High Temperature

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The outline of the presentation

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Introduction

1. The use of high strength concrete increased significantly in construction sector in the last years
2. Fire is one of the hazards that attack structure
3. The exposure to high temperature results in significant reductions in strength for concrete
4. Explosive spalling is occurred when a high strength concrete columns exposed to fire

Spalling of concrete in the face of fire

Problem statement

Fire causes serious damages to structures. Dramatic strength reduction and explosive spalling are some defects of high strength concrete when exposed to high temperature.

Objectives

- Determining the residual strength of high strength concrete after exposure to high temperature.
- Controlling the sensitivity of high strength concrete columns to their unstable spalling behavior during fire by choosing the right section geometry.
- Making visual detections for cracks and color changing for high strength concrete before and after exposure to different high temperatures.

Materials and Methods

- Producing high strength concrete.
- The mix design was done according to ACI 211.1.
- Preparing high strength concrete cubes and cylinders were made by using BS EN 12390-3:2009 and ASTM C39 / C39M - 15a.
- Polypropylene fibers were used to reduce the spalling effect.
- The specimens were cured in water for 7, 28 and 90 days.
- The specimens were subjected to 450 and 650^{o}C for 2 hrs.
- Heated and non-heated specimens were subjected to compression test.

Mix Code	Cement Kg.	Gravel Kg.	Sand Kg.	Water Kg.	Alum sludge Kg.	Super plasticizer Kg.	Polypropylene Fiber Kg/m^3	Slump mm	Flow mm
P	480	930	870	180	0	5	0	240	550
PP	480	930	870	180	0	5.5	1	240	550

Mix proportions per one meter cube of concrete

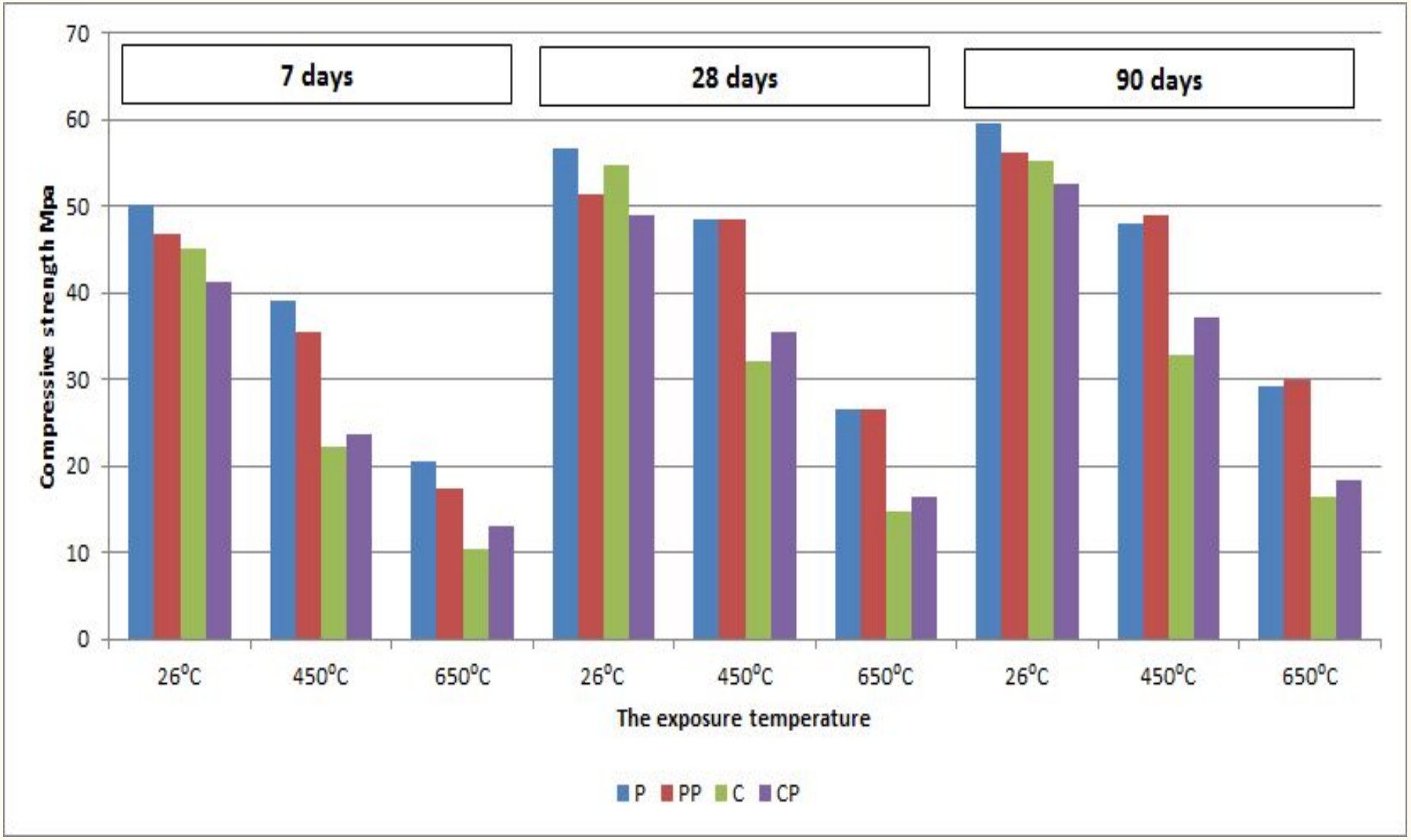
P for control specimens without polypropylene fiber

PP for polypropylene fiber contained specimens.

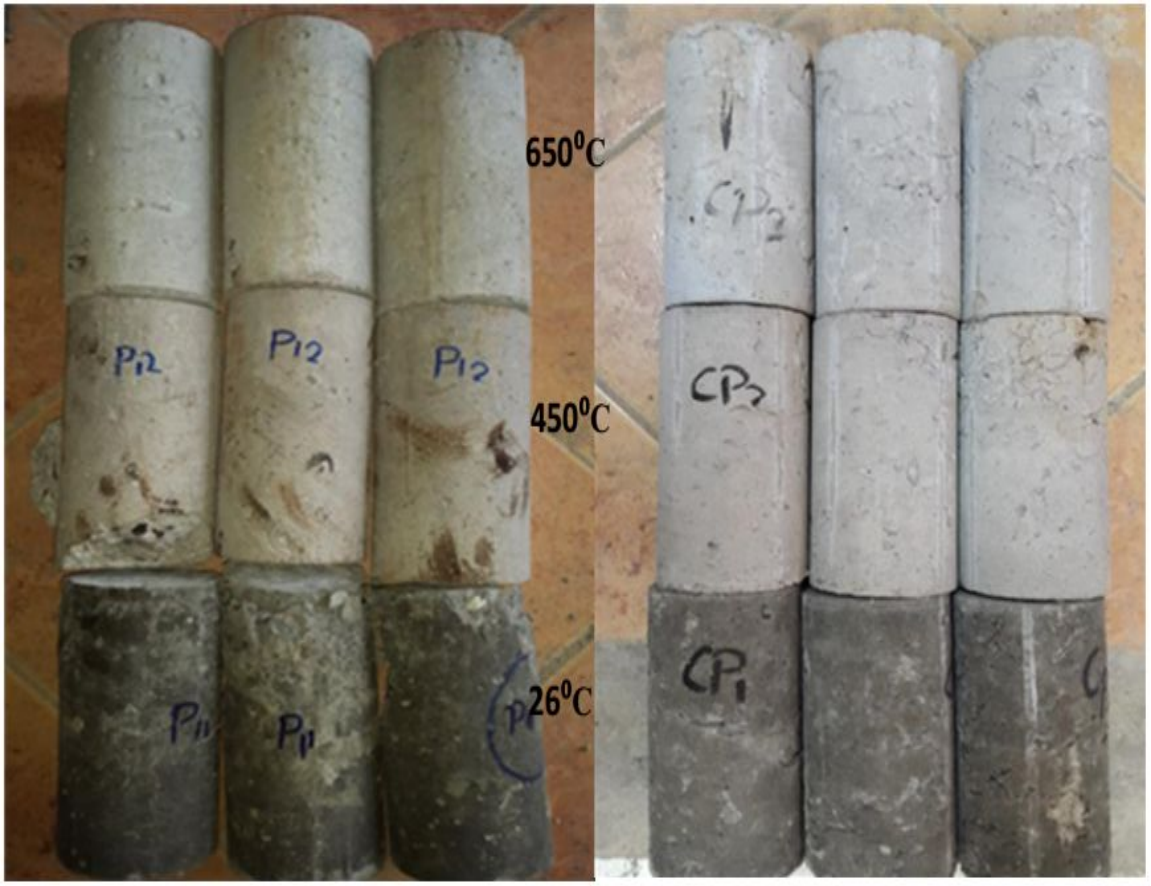
Results and Discussion

Specimens	Compressive strength for different curing regimes and different exposure temperatures (MPa)								
	7 Days			28 Days			90 Days		
	26°C	450°C	650°C	26°C	450°C	650°C	26°C	450°C	650°C
P	50.09	39.06	20.44	56.68	48.47	26.61	59.55	48.05	29.29
PP	46.82	35.37	17.48	51.44	48.45	26.59	56.29	49.04	30.03
C	45.16	22.27	10.48	54.89	32.13	14.79	55.18	32.79	16.50
CP	41.22	23.71	12.95	48.94	35.60	16.44	52.68	37.26	18.34

P: Control cube specimens
PP: Polypropylene contained cube specimens
C: Control cylinder specimens
CP: Polypropylene contained cylinder specimens


7 days
28 days
90 days
Compressive strength Mpa
70
60
50
40
30
20
10
0
26°C
450°C
650°C
26°C
450°C
650°C
26°C
450°C
650°C
The exposure temperature
P
PP
C
CP

Visual Detections



Cylinder specimens after exposure to different temperatures

Cube specimens after exposure to different temperatures

Conclusions

- It is possible to produce high strength concrete having 90 day compressive strengths up to 59.55 MPa for cubes and 55.18 MPa for cylinders.
- Maximum residual compressive strength of 49.04 MPa was recorded for 90 day cured polypropylene contained cube specimens after exposure to 450^{o}C.
- Maximum residual compressive strength of 30 MPa was recorded for 90 day cured polypropylene contained cube specimens after exposure to 650^{o}C.
- The incorporation of polypropylene fibers enhances the residual strength for both cube and cylinder specimens after exposure to high temperature.
- The rectangular sections are more resistible to the exposure to high temperature than the circular ones.
- The exposure to 650^{o}C induced in visual cracks on concrete surface.