ISSN (online): 2349-6010

A Study on Effect of Mechanical Properties of Recron 3S Fibre Concrete on Different Grades Exposed to Elevated Temperatures

Mylavarapu Phani Sekhar
PG Student
Department of Civil Engineering
Srinivasa Institute of Engg. & Technology, Amalapuram, Andhrapradesh, India.

K. Raju
Assistant Professor
Department of Civil Engineering
Srinivasa Institute of Engg. & Technology, Amalapuram, Andhrapradesh, India.

Abstract

The concrete elements such as beams, columns, slabs etc., prone to sudden fire break out of fire are subjected to extreme temperatures. Their performance and assessment after exposed to fire becomes necessary to decide upon its fitness and required measures for the repair of different elements. Therefore, it is necessary to understand the changes in the concrete properties due to its exposure to extreme temperatures. It is very essential to know the effect of elevated temperature on the properties of concrete. This paper investigates the effect of sustained elevated temperature on the properties of ordinary concretes of three different grades i.e., M30, M35 and M40 grades, containing 53 grade of cement. The specimens were heated to 150^0C, 250^0C and 300^0C at 1 hour, 2hours and 3hours duration in muffle furnace. They were tested for compressive and split tensile strengths after air cooling to the room temperature. The variables considered in the study include type of cementing material, and temperature. The compressive and tensile strengths of concrete decreased with increasing temperature. And also recron 3s fiber material is used for increasing the strength of the concrete at various temperatures. In this experimental study Recron 3s fiber has been added to concrete in order to enhance the strength characteristics of the concrete in percentages of 0.10%, 0.15%, 0.20%, 0.25%, 0.30%, 0.35% and 0.40% to the weight of concrete and the optimum fiber content for Compressive and Tensile strengths were obtained and it can be used for further study for determining the Compressive and Tensile strengths of the conventional concrete without using recron 3s fiber and concrete with recron 3s fiber material at various elevated temperatures and were observed at 1hour, 2hours and 3hours duration for the age of 7 days to 56 days.

Keywords: Recron 3s Fiber, Elevated temperature, conventional concrete, Muffle furnace

I. INTRODUCTION

Human safety in the event of fire is one of the considerations in the design of residential, public and industrial buildings. Concrete has a good service record in this respect. Elevated temperature is one extreme condition to which concrete structure could be exposed. Examples of such conditions are concrete foundations for launching rockets carrying spaceships, concrete structures in nuclear power stations. 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 condition 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 in industrial chimneys, air craft runway etc., will be subjected to elevated temperatures.

II. LITERATURE REVIEW

H. G. Mundle (2014) studied the Variation in Strength of Concrete Subjected to High Temperature. The compressive strength was found to increase after 24 hours of exposure to an elevated temperature up to 200^0C after that compressive strength of concrete will be decreases with increasing temperature after the peak point.

Siddesh & Kaushik Chandra (2013) studied the performance of polyester fiber reinforced concrete (Recron 3s) were subjected to different elevated temperatures for an exposure of 2 hours.Their test results showed that the compressive strength was decreases as the temperature increases.

L. A. P. Lourenço et al [Feb 2011] conducted experiments on polypropylene fibers. Increasing the Polypropylene fiber dosage from 1 to 2 kg/m^3, the compressive residual concrete behaviour was not significantly improved. The highest difference was registered for a maximum temperature of 250^0C.

III. Materials

The materials used in this investigation are Cement, Fine aggregate, Coarse aggregate, Recron 3S polypropylene fibres and water.

1) Cement: The cement used in this study is Jaypee Ordinary Portland Cement of 53 Grade confirming to IS: 8112-1989.
2) Fine Aggregate: The river sand obtained from the river Godavari confirming to IS: 383-1970 and also confirming to grading Zone II as per Table 3 of IS: 10262-2009 is adopted.
3) Coarse Aggregate: Aggregates of size 20 mm confirming to IS 383: 1970 are taken. Recron 3S Fiber: Recron 3s fiber was used as a secondary reinforcement material. Reliance Industry Limited (RIL) has launched Recron 3s fibres.

Fig. 1: Recron 3s Fiber

Table – 1

S.No	*Property*	*Specification*
1	*Cross-section*	*Triangular*
2	*Diameter*	*35-40 micron*
3	*Color*	*White*
4	*Cut Length*	*6mm, 12mm, 24mm*
5	*Dispersion*	*Excellent*
6	*Acid resistance*	*Excellent*
7	*Alkali resistance*	*Good*
8	*Specific gravity*	*1.36*
9	*Melting point*	*240-260^0 Celsius*
10	*Flash point*	*>329^{0}C*
11	*Relative Density*	*0.89-0.94 g/cm^3*
12	*Elongation*	*45-55%*
13	*Young's Modulus*	*17.5x10^3 Mpa*
14	*Tensile Strength*	*4000-6000 Kg/cm^2*
15	*Moisture*	*<1%*

IV. Experimental study

This experimental study comprises of the following steps:

1) Collection of Materials
2) Mix Design
3) Casting of Specimens
4) Curing of Specimens
5) Testing of Specimens

A. *Testing of Specimens:*

The tests on the hardened concrete are carried out to check its compliance with specifications, assess the quality of concrete in the structure, the load carrying capacity, and the strength of concrete at a particular location in the structure. A time schedule for testing of specimens is maintained to ensure their proper testing on the due date and time. The cast specimens are tested as per standard procedures, immediately after they are removed from curing tanks and wiped off the surface water, as per IS 516-1959.

B. *Compressive Strength Test:*

The compressive strength of concrete was calculated using the following formula:

$F_C = P/A$ Where,

F_C = Compressive strength of concrete.
P = Maximum load applied to the specimen in newtons.
A = Cross sectional area of the specimen in mm^2.\

C. Split Tensile Strength Test:

The split tensile strength of concrete was calculated using the following formula:

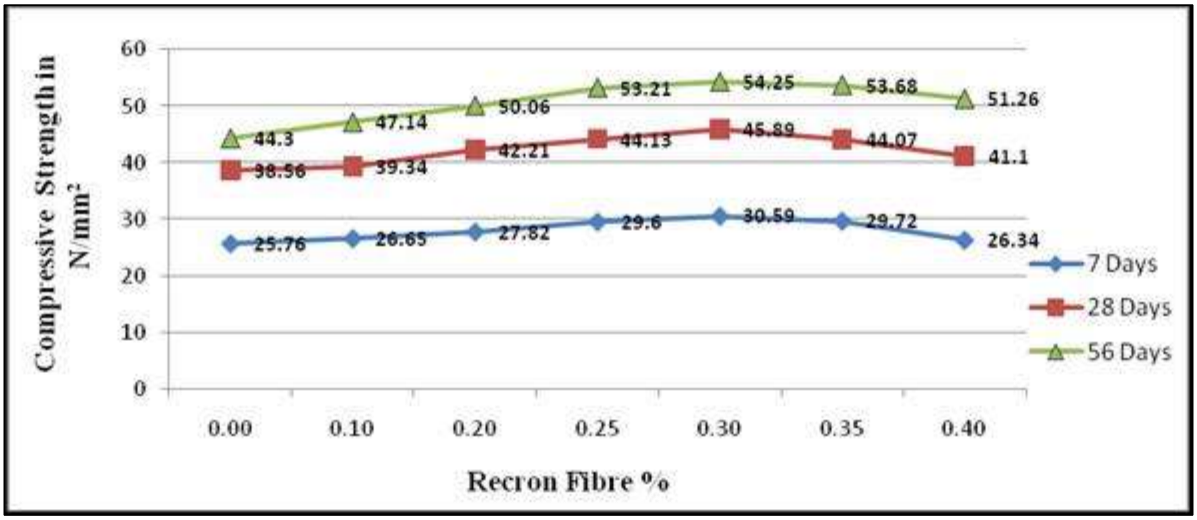
$F_S = \frac{2P}{\pi dl}$ Where,

F_C = Split Tensile strength of concrete.
P = maximum load on the specimen in Newton's.
d = diameter of the cylinder im mm (i.e, 150mm).
l = length of the cylinder in mm (i.e, 300mm).

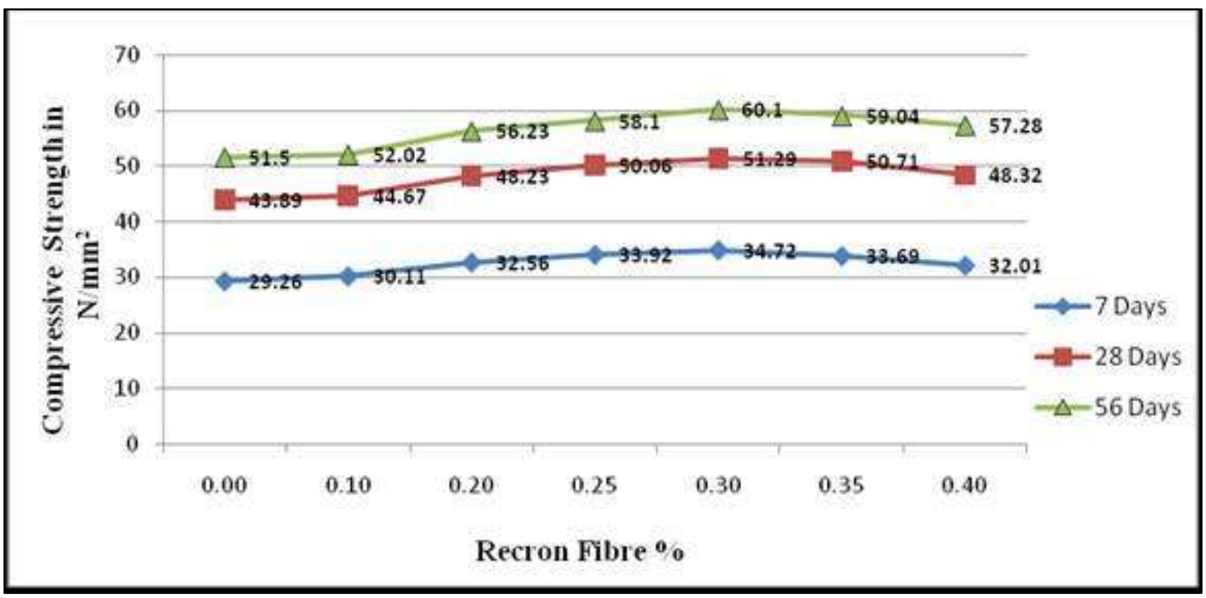
D. Muffle Furnace:

A Muffle furnace in historical usage is a furnace in which the subject material is isolated from the fuel and all of the products of combustion including gases and flying ash. After the development of high-temperature electric heating elements and widespread electrification in developed countries, new muffle furnaces quickly moved to electric designs.

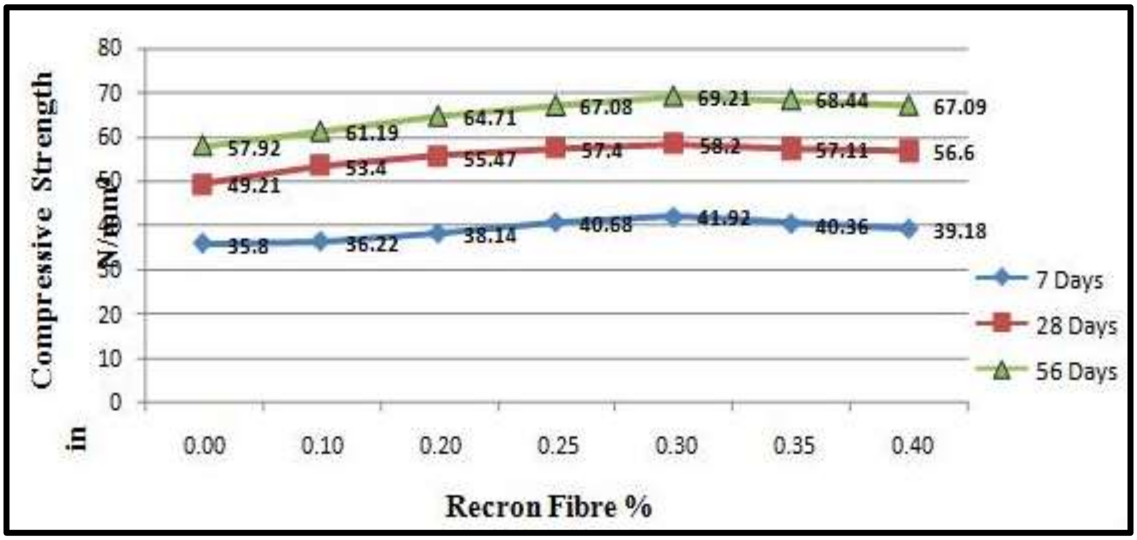
V. RESULTS & DISCUSSIONS



Graph: Variation of Compressive Strength results for M30 Grade of Concrete with different percentages of Recron Fiber.

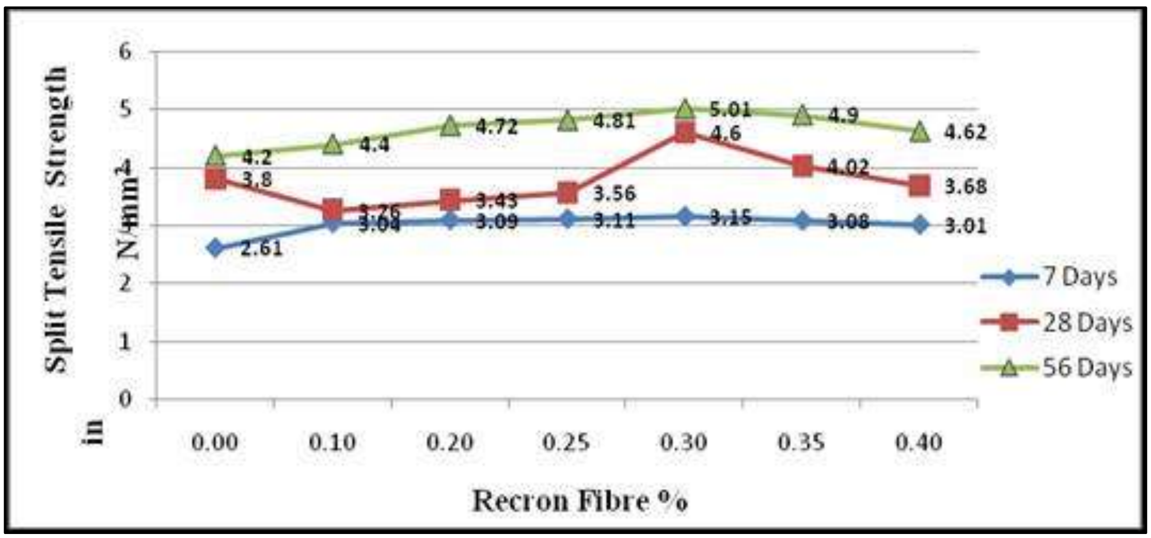


Graph: Variation of Compressive Strength results for M35 Grade of Concrete with different percentages of Recron Fiber.

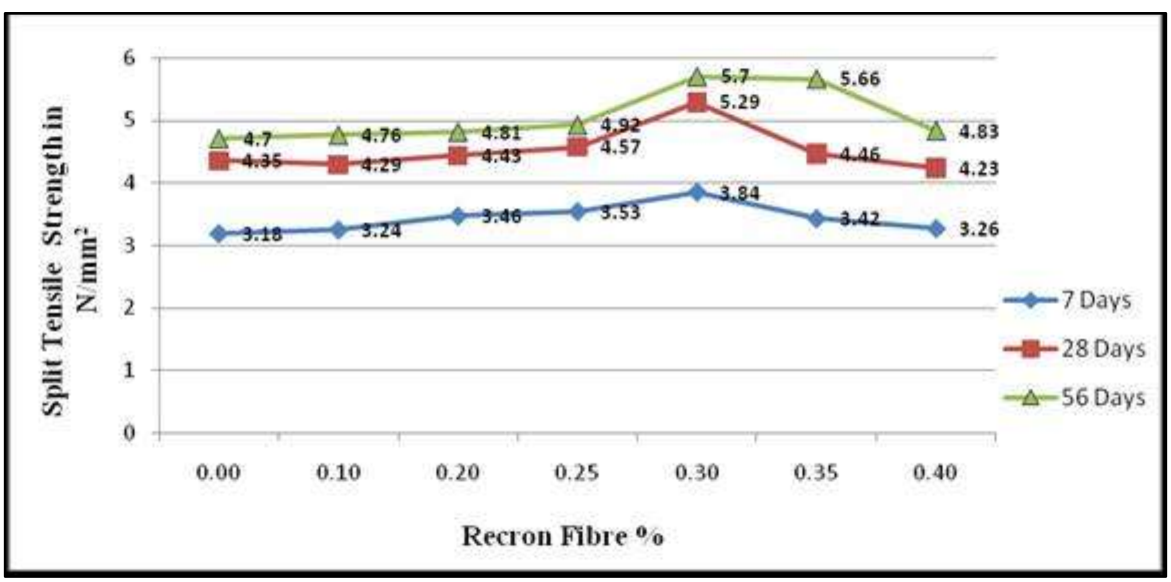


Graph: Variation of Compressive Strength results for M40 Grade of Concrete with different percentages of Recron Fiber.

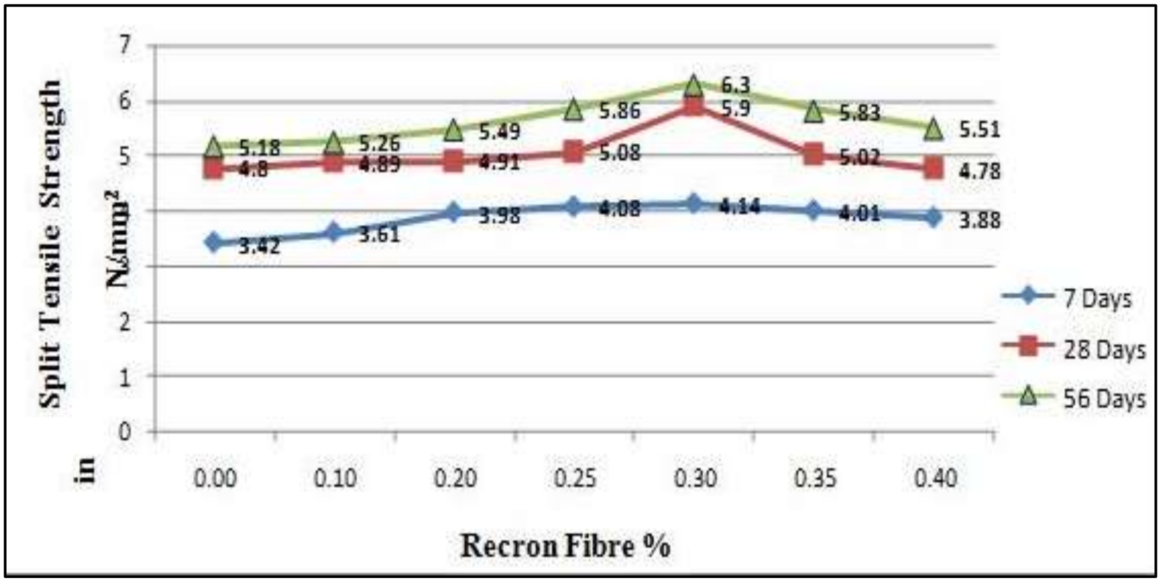
A. *Test Result of Split Tensile Strength of Concrete Specimens:*



Graph: . Variation of Split Tensile Strength results for M30 Grade of Concrete with different percentages of Recron Fiber.



Graph: Variation of Split Tensile Strength results for M35 Grade of Concrete with different percentages of Recron Fiber.



Graph: Variation of Split Tensile Strength results for M40 Grade of Concrete with different percentages of Recron Fiber.

VI. CONCLUSION

The following are the conclusions based on the experimental study carried out on the strength behaviour of concrete.

1) The Compressive and Split Tensile strengths of concrete (with or without addition of Recron 3s) cured in water for 28 days have reached the target mean strength.
2) Recron 3s fiber has been added in percentages of 0.10%, 0.15%, 0.20%, 0.25%, 0.30%, 0.35% 0.40% to the weight of concrete and the optimum fiber content for Compressive and Tensile strengths are obtained at 0.3% and on further increment of fiber the strength reduces for all the three grades of concrete i.e. M30, M35 and M40.
3) The Compressive strengths and Split tensile strengths of concrete were found to increase when they are exposed to temperatures between 150^0C - 250^0C with or without adding of Recron 3s fiber at 7 days, 28 days and 56 days for 1hr and 2 hrs duration.
4) The maximum percentage increase in the Compressive strength for Recron 3s fiber concrete for M30 grade when the specimens are exposed to 150^0C and 250^0C in the duration of 1hr, 2hrs and 3hrs is 18-20% for 28 days, for M35 grade when the specimens are exposed to 150^0C and 250^0C in the duration of 1hr, 2hrs, and 3 hrs the increase in strength is 18-21% for 28 days, and for M40 grade when the specimens are exposed to 150^0C and 250^0C in the duration of 1hr, 2hrs, and 3hrs the increase in strength is 19-20% for 28 days. At 300^0C, the compressive strength of specimens in the duration of 1hr, 2hrs and 3hrs for M30, M35 and M40 grades Recron 3s fiber concrete is suddenly decreased, when compared to conventional concrete, as recron crosses its melting point.
5) It is observed that the tensile strength is also increased when the specimens are exposed to 150^0C and 250^0C temperature and then the strength is decreased when increase in temperature.
6) The maximum percentage increase in the Tensile strength for Recron 3s fiber concrete for M30 grade when the specimens are exposed to 150^0C and 250^0C in the duration of 1hr, 2hrs and 3hrs is 20-22%, for 28 days, for M35 grade when the specimens are exposed to 150^0C and 250^0C in the duration of 1hr, 2hrs, and 3 hrs the increase in strength is 19-21%, for 28 days, and for M40 grade when the specimens are exposed to 150^0C and 250^0C in the duration of 1hr, 2hrs, and 3hrs the increase in strength is 20-23% for 28 days. At 300^0C, the tensile strength of specimens in the duration of 1hr, 2hrs and 3hrs for M30, M35 and M40 grades Recron 3s fiber concrete is suddenly decreased, when compared to conventional concrete, as recron crosses its melting point.
7) When compared with conventional concrete, the compressive strengths were found to be decreased when the cubes were exposed to temperature at 300^0 C for 1hr, 2hrs and 3hrs duration, because of 250^0C is the melting point for Recron 3s.
8) Recron 3S prevents the micro shrinkage cracks developed during hydration. Addition of Recron 3s to concrete and plaster arrests cracking caused by volume change (expansion and contraction), simply because 1kg of Recron 3s offers millions of fibers which support mortar/concrete in all directions.
9) The use of FRC reduces water penetration and permeability by more than 50% w.r.t control according to IS 2645 stipulations it can also be used as waterproofing admixture.
10) The reduction in Compressive and Tensile strengths are due to water loss of crystallisation resulting in reduction of $Ca(OH)_2$ content and the formation of micro cracks due to exposure to heat.

REFERENCES

[1] Bureau of India Standard, "Indian standard concrete mix proportioning – Guidelines" (First revision) IS-10262:2009, New Delhi, India.
[2] Bureau of India Standard, "Code of practice for plain and reinforced concrete", fourth edition, IS-456:2000, New Delhi.
[3] Indian Standard IS-12269:1987, "Specifications for 53 grade Ordinary Portland Cement"
[4] Indian Standard IS-383:1970, "Specifications for Coarse and Fine aggregates".
[5] IS:2386 (Part I)-1963 Indian standard ,Methods of test for aggregates for concrete - Part I particle size and shape, Bureau of Indian standard, 1997, New Delhi
[6] Concrete Technology and Practice by M.L. Ghambir.
[7] Concrete Technology Theory and Practice by M.S. Shetty.
[8] Neville, A. M., "Concrete Technology", Fourth edition, Pearson Education, New Delhi.
[9] H.G. Mundle,"Variation in Strength of Concrete Subjected to High Temperature", IJRET, lecturer of Civil Engineering, Shri Data Meghe Polytechnic, Nagpur, Maharashtra, India.
[10] Binni Babuji, Shibi Varghese, "Experimental study on the performance of hybrid fibre reinforced concrete at elevated temperatures", Department of Civil Engineering, M G University.
[11] Siddesh Pai & Kaushik Chandra (2013), "Analysis of Polyester Fiber Reinforced Concrete subjected to elevated temperatures", IJCSEIERD.
[12] Belkacem Toumiet al., (2010), "Influence of High Temperatures on Surface Cracking of Concrete Studied by Image Scanning Technique".
[13] D. J. Naus et al., (2005), "Effect of elevated temperature on concrete materials and structures".
[14] V.K.R. Kodur and M.A. Sultan "Effect of temperature on thermal properties of concrete" Journal of materials in Civil Engineering April2003.
[15] "Study on Effects of elevated temperatures on high performance concrete with Metakaolin as admixture" by A.Srinivas.2004 Anantapur