EFFECT OF ELEVATED TEMPERATURE ON CONVENTIONAL CONCRETE BY RELACING CEMENT PARTIALLY WITH METAKAOLINE.

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Abstract—Metakaoline is a cementetious materials used as an admixture to produce high strength concrete and is used for maintaining the consistency of concrete. Metakaolin is a valuable admixture for concrete or cement applications and it is a pozzolanic additive product which can provide many specific features. Amongst the various methods used to improve the durability of concrete, and to achieve high performance concrete, the use of Metakaolin is a relatively new approach.The present study includes the effect of partial replacement of cement with metakaolin by various percentages (0%, 10%, 15%, 20%) on the properties of M-25 grade of concrete, when it is subjected to high temperature of 200^0C – 1000^0C. The concrete mixes were prepared by replacing 0,10,15 and 20% mass of cement by Metakaolin. The specimens were heated to different temperatures of 200^0C,400^0C,600^0C,800^0C,1000^0Cfor durations of 1 hours at each temperature. The results conclude that the use of Metakaolin Concrete (MKC) has improved the performance of concrete under various temperature conditions.The test result revealed that 15% replacement of OPC by metakaolin increases the strength of concrete.

Keywords— Metakaoline,OPC,Compressive strength.

1. INTRODUCTION

Concrete is the most widely used and versatile building materials which is generally used to resist compressive force. By addition of some pozzolanic materials. the various properties of concrete viz, workability, durability, Strength resistance to cracks and permeability can lie improved. Many modernconcrete mixes are modified with addition of admixture which improve the microstructure as well as decrease the calcium hydroxide concentration by consuming it through a pozzolanic reaction. Metakaolin is pozzolanic materials which is manufactured from selected kaolnis, after refinement and calcination under specific condition. It is a. highly efficient pozzolana and react rapidly with the excess calcium hydroxide resulting from CPC hydration by a pozzolanic reaction, to produce calcium silicate hydrate and calcium aluminosilicate hydrates.

Metakaolin is a pozzolanic material which is manufactured from selected kaolins after refinement and calcinations under specific conditions. It is highly efficient pozzolanic material and react rapidly with the excess calcium hydroxide resulting from OPC hydration

Cement + Water = Calcium Silicate+ Calcium Hydroxide.

OPC + H20 = Ca,O4Si + Ca(OH)2
(cementitious) (non-cementitious)

Calcium Hydroxide+ Metakaolin = Calcium Aluminate + Calcium Alumino Silicate.
(Ca(OH))(CaOA1,03)(CaAl2S1,08) (cementitious)

2. LITERATURE REVIEW:-

(D. L. Fillmore)[2] 2000

Work: Temperature and radiation effect on concrete.

Conclusion: Long term exposure of concrete to elevated temperature which leads to decease in compressive strength and changes in the modulus of elasticity. Rapid increase in temperature leads to concrete degradation.

(David N. Bilow)[1] 2008

Work:- Complex behavior of structure in fire

Conclusion:- Rise in temperature causes a decrease in the strength and modulus of elasticity for concrete and steel reinforcement.

(Anand N.)[1,] (Prince Arulraj G.)[2] 4, 2011

Work: Effect of elevated temperature on concrete materials.

Conclusion: It was reported that the behavior normal strength concrete, high strength concrete and self-compacting concrete were different when expose to high temperature.

(Hemant Chauhan)[1] 2011

Work:- Use industrial wastes like activated Fly ash, Iron Oxide and Metakaolin as supplementary cementitious materials in various proportions.

Conclusion:- It was possible to make the concrete economical by 42% replacement of cement with different percentages of mineral admixtures like Fly ash (30%), Metakaolin (10%) and iron oxide (2%).

(Alaa M. Rashad)[3] March 8, 2014

Work: Metakoline used as an optimum content for mechanical strength in traditional cementitious materials.

Conclusion: The used of metakoline in cement system improves mechanical strength such as tensile strength, flexural strength and pull out strength

3.EXPERIMENTAL INVESTIGATION:-

Material cements:-

In this experimental investigation Ordinary Portland Cement of 53 grade (ultratech cement) was used.

Fine Aggregates:-

The fine aggegates used in this investigation wasRiver sand passing through 4.75 mm sieve with specific gravity of 2.51.The percentage of passing is within the limits as Indian Standard Specification. The fine aggregate corresponds to the zone II gradation as per IS 383:1970.

Coarse aggregates :-

Machine crushed broken stone angular in shape was used as coarse aggregates. Coarse aggregates of 20mm size having specific gravity of 2.74.

Water:-

Ordinary tape water clean, potable free from suspended particles and chemical substance was used for both mixing and curing of concrete.

4. Metakoline

Metakolin is a dehydrated form of the clay mineral kaolinite. Itis an amorphous non crystallized material which consists of lamellar particles. Research on Metakolin shows that it is an excellent pozzolanic material which can improve strength, durability, and other mechanical properties of concrete.

Chemical formula:- $Al_2O_3.2SiO_2.2H_2O$

Chemical Composition	
SiO_2	58.03 %
Al_2O_3	36.32 %
Fe_2O_3	0.95 %
TiO_2	1.30 %
CaO	0.06 %
MgO	0.36 %
Na_2O	0.12 %
K_2O	0.00 %
LOI	2.85 %

Physical Composition	
Specific Gravity	2.50
Moisture	0.01%
Whitness Index	78.45%
pH	6.4
Pozzolanic reaction	3-14 days

5.MIX PROPORTION:-

Sr No.	Mix	Cement Kg/m^3	Fine aggregate Kg/m^3	Coarse aggregate Kg/m^3	W/C	Metakaoline Kg/m^3
1	M (0%)	413.33	651.25	1159.94	0.45	------
2	M (10%)	372	651.25	1159.94	0.45	41.33
3	M (15%)	351.33	651.25	1159.94	0.45	62
4	M (20%)	330.67	651.25	1159.94	0.45	82.66

Mix Proprotion :-

Quantity in	cement	Water	Fine aggregate	Coarse aggregate
Kg	413	186	651.25	1159.94
Volume m^3	1	0.45	1.57	2.80

The mix prportion for**M_{25} = 1 : 1.57 : 2.80**

6.TEST RESULT

Conventional Concrete

Cube			Cylinder			Beam		
Compressive strength (N/mm^2)			Split tensile strength (N/mm^2)			Flexural strength (N/mm^2)		
7 days	14 days	28 days	7 days	14 days	28 days	7 days	14 days	28 days
31.93	26.59	31.83	2.08	2.63	3.75	2.57	3.53	4.19
29.65	30.52	34.44	2.35	3.05	3.05	2.20	3.60	3.68
28.34	31.83	32.7	2.49	3.19	3.47	1.98	3.16	3.75

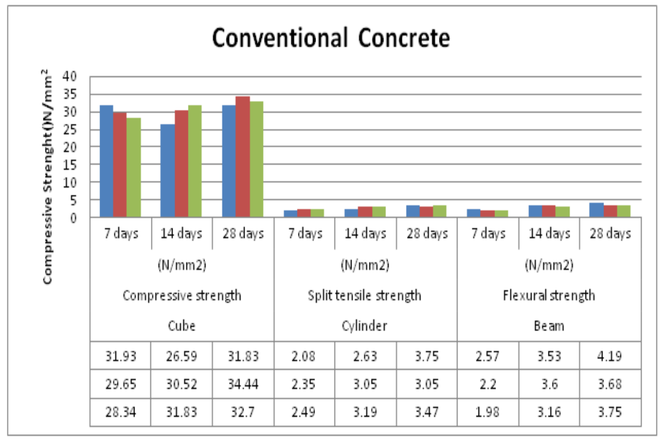


Figure:- 7, 14 , 28days strength of concrete.

Conventional concrete at different temperature

Temperature	Cube Compressive strength (N/mm^2)	Cylinder Split tensile strength (N/mm^2)	Beam Flexural strength (N/mm^2)
200	34.08	3.33	1.76
400	29.21	2.77	2.06
600	29.21	2.50	0.515
800	25.25	0.97	0.059
1000	16.57	0.55	0

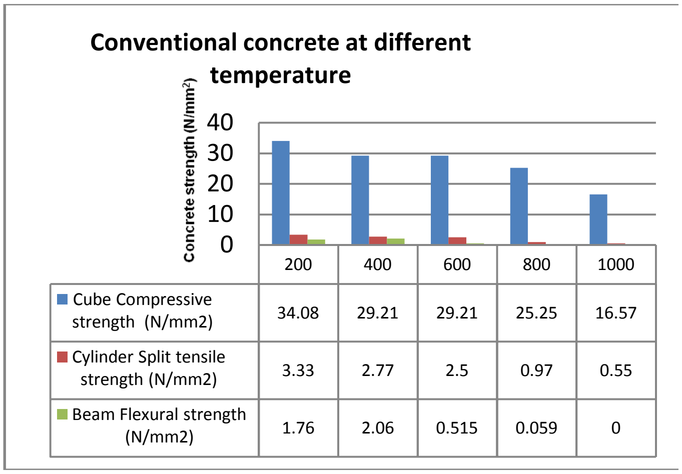


Figure:-Conventional concrete at different temperature

Concrete with Metakoline

Temperature	Metakaoline								
	10% replacement			15% replacement			20% replacement		
	Cube	Cylinder	Beam	Cube	Cylinder	Beam	Cube	Cylinder	Beam
200 $^{\circ}$C	31.83	2.77	1.83	34.88	3.47	2.43	32.7	3.33	2.20
400 $^{\circ}$C	28.34	2.22	1.98	30.52	3.05	2.20	29.65	2.77	2.28
600 $^{\circ}$C	26.16	1.94	0.59	29.64	2.50	1.03	27.47	2.35	0.73
800 $^{\circ}$C	25.29	0.97	0.037	28.34	1.25	0.074	25.72	0.69	0.05
1000 $^{\circ}$C	16.13	0.55	0	19.62	0.83	0	17.44	0.83	0

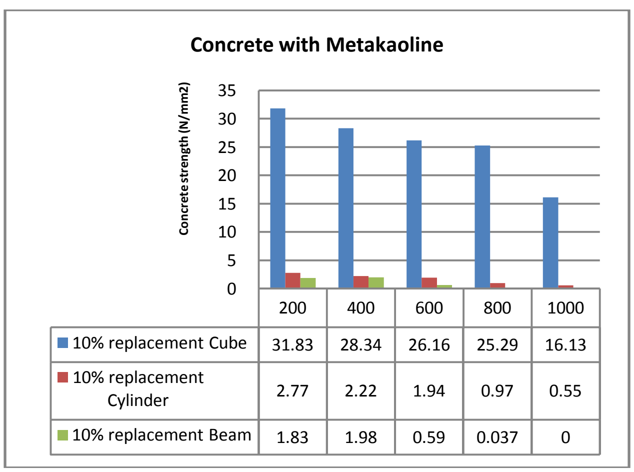


Figure:-10% replacement of cement with metakaoline.

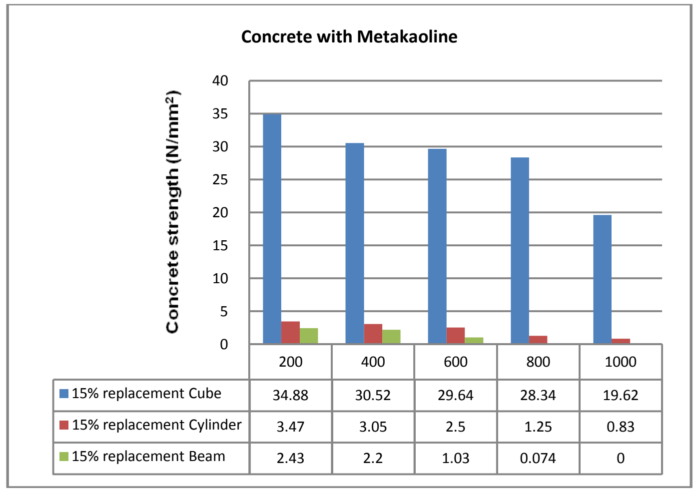


Figure:-15% replacement of cement with metakaoline.

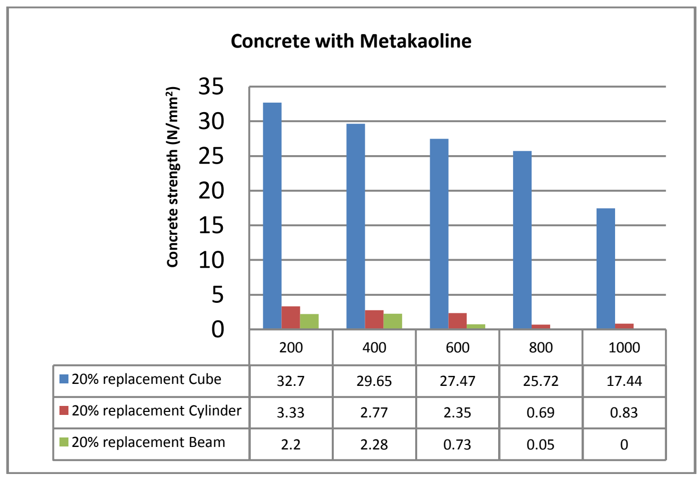
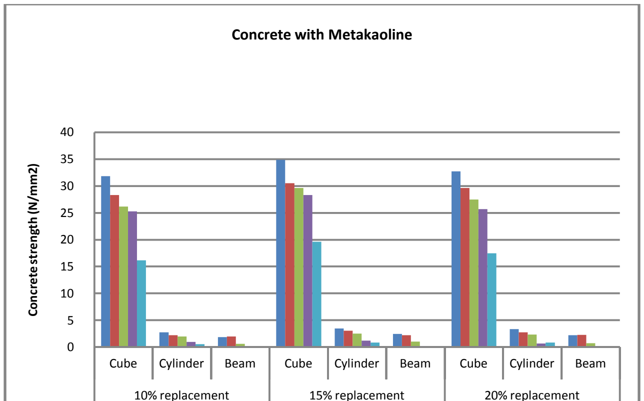


Figure:-20% replacement of cement with metakaoline.



Temperature	10% replacement Cube	10% replacement Cylinder	10% replacement Beam	15% replacement Cube	15% replacement Cylinder	15% replacement Beam	20% replacement Cube	20% replacement Cylinder	20% replacement Beam
200	31.83	2.77	1.83	34.88	3.47	2.43	32.7	3.33	2.2
400	28.34	2.22	1.98	30.52	3.05	2.2	29.65	2.77	2.28
600	26.16	1.94	0.59	29.64	2.5	1.03	27.47	2.35	0.73
800	25.29	0.97	0.037	28.34	1.25	0.074	25.72	0.69	0.05
1000	16.13	0.55	0	19.62	0.83	0	17.44	0.83	0

Figure:-10%,15%20% replacement of cement with metakaoline.

7. CONCLUSION

1. After elevated temperatures test and analysis it was found that with the increasing temperature the compressive strength, tensile strength and flexural strength of concrete gets reduced.
2. As temperature and exposure time increases the effect of fire on concrete increases.
3. Effect of fire can be observed on the surface of concrete in the form of deep cracks.
4. Between 400-600°C temperature Strength loss starts.
5. Above 600°C temperature concrete is not functioning at its full structural Capacity.
6. At elevatedtemperatu
re the concrete becomes more & more brittle and the loss of strength is more than 30%.
7 At 600°C temperature whitish colour and at 800°C temperature dark brown colour appears on the surface of cubes.
8.At 1000°C temperature hair cracks developed on specimen.
9. Test result shows that replacing cement partially with metakolin upto 15% gives good strength result and durability also improve to certain extent.

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