Temperature Controlled Self Compacting High-Performance Concrete

Kuppala. V. V. N. Gopi Chaitanya, Anirudh Maddi

Abstract: ***In mass concrete works, when normal water is used in preparing the concrete mix, it leads to high amount of heat of hydration and thermal cracking, but with the use of chilled water for the same, the amount of heat that is produced in the concrete can be dissipated and thereby reducing the thermal cracks. The concrete mix thus produced is called Temperature controlled concrete. The present work carried out results in Temperature Controlled Self Compacting High-Performance Concrete. This is achieved by studying the self-compacting properties at the fresh state of concrete along with the durability and strength properties of the concrete. Several tests were carried out by using various supplementary cementitious materials and super plasticizer to obtain self-compacting concrete with high performance. The mix thus prepared constitutes 22% of Fly ash and 5% of Alccofines by replacing binder content in the concrete. Comparative study on the compressive strengths of the mixes prepared with nominal concrete, concrete with fly ash and concrete with fly ash and alccofine together was done. From the tests, the results achieved show's that, the mix prepared with the Alccofine gives more strength when compared with other mixes. This is due to the usage of supplementary cementitious material and their fineness properties along with water retarding super plasticizer. This will enhance the flow and durability properties of the concrete.***
Keywords: Alccofine, Super Plasticizer, Heat of Hydration.

I. INTRODUCTION

Generally working with the high grades of concrete in construction will lead to thermal cracks in the concrete due to the large amount of heat of hydration generated from the cement, and this can be overcome by reducing the temperature of the concrete. To bring down the concrete temperature, the chilled water is used in the concrete at the time of mixing. It is difficult to place the concrete where the congested reinforcement is available, due to that congested reinforcement the manual compaction is not possible after placing the concrete and to place the concrete even in the places where the congested reinforcement is available the concrete should compact upon its own weight without any external vibration. To achieve the self-compacting property in the concrete the supplementary cementitious Designing the concrete with high- performance is required to make the concrete sustainable for the long time, to make the concrete sustainable towards chemical attacks, to obtain that the mix is prepared with SCM's whose finer particles will not allow the concrete to fail in the Durability properties with strength and thus the Temperature Controlled Self Compacting High-Performance Concrete is suitable to obtain to overcome the Thermal stresses, consolidation problems at congested reinforcement, and make the structure sustainable for the long time without any failure.

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II. MATERIAL PROPERTIES

Cement: The Cement used is Ordinary Portland cement of grade 43.

Table I. Physical Properties of Cement

Property	OPC 43 Grade
Normal Consistency (%)	29
Initial setting Time (min)	150
Final setting Time (min)	275
Specific Gravity	3.15

Table II. Chemical Properties of Cement

SiO2	20.0
Al2O3	5.0
Fe2O3	3.0
Cao	65.0
Mgo	1.1
So3	2.4
Na2O3	0.2
K2O	0.9

Fly ash: Fly ash is the industrial by-product from the coal industry which can

be used as a mineral admixture, it reduces the heat of hydration and increases the workability of concrete.
According to ASTM-C618 fly ash is classified into two types.

- Class F - Low calcium Fly ash (less calcium content)
- Class C – High calcium Fly ash (20% more calcium content)

Table III. Physical & Chemical Properties of Fly ash

Parameters	Class F Fly ash
Sio_2	55.0
Al_2O_3	26.0
Fe_2O_3	7.0
CaO	9.0
MgO	2.0
SiO_3	1.0
Fineness (m^2/kg)	340
Bulk Density (kg/m^3)	900
Specific Gravity	2.12

Alccofine: The Alccofine is the by-product of silica slag and it pozzolanic property makes the alccofine to used as a supplementary cementitiousmaterial and fineness properties of alccofine helps to enhance the mechanical, flow properties and helps to make the concrete high durable.

Table IV. Physical properties of Alccofine

Property	Alccofine
Specific Gravity	2.62

Fine aggregates: River sand was used as fine aggregate.

Table V. Physical properties of Sand

Property	Result
Specific gravity	2.70
Bulk Density (kg/m^3)	1726.6
Water Absorption	1.53%

Coarse Aggregate:

Table VI. Sieve Analysis of 20 mm Aggregat

Sieve size (mm)	% Passing (20 mm)
40	100
20	96.20
16	-
12.5	-
T 10	2.77
4.75 a	0.10

Sieve size (mm) B	% Passing (12.5 mm)
16	99.77
12.5	99.13
10	77.53
4.75	0.73

Table VII. Sieve analysis for 12.5 mm Aggregate

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Super plasticizer: MYK Remicrete PC30

III. METHODOLOGY

Phase-1 Collection of the materials for the preparation of concrete, testing the raw materials for the concrete, preparation of mix design, performing trial mixes and observing the properties of concrete
Phase-2 Conforming the mix design, testing properties of fresh concrete, testing mechanical properties of concrete and testing the durability properties of concrete.

PREPRATION OF CONCRETE:

The mix design was prepared according to the IS10262 2009, The M60 grade concrete was prepared by cement, coarse aggregate, fine aggregate, water, super plasticizer and in this mix design the cement content is replaced with supplementary cementitious materials (fly ash and alccofine).
This mix contains 73% of cement, 22% Fly ash, and 5% Alccofines with 0.30 w/c ratio.

IV. TESTS AND RESULTS ON CONCRETE

Flow properties of concrete:

Table VIII Flow Properties of Concrete

Minutes	0	30	60	90	120
Flow	690	650	600	580	530
Temperature	27.5	26.4	26.4	28	28.2

Comparative study between the different admixture proportions in the concrete mix: The different percentages of super plasticizer is used in the concrete mix and their properties were studied and at 0.9% super plasticizer the self-compacting concrete is obtained

Weight (g)	Load (KN)	Strength (N/mm^2)
8520	1850	82.22
8370	2000	88.88
8425	2000	88.88

Results for V-Funnel Test on concrete:

Table IX Results of V-funnel Test

	Ti	T30	T60	T120
Time (seconds)	14	10	10	14

Tests on mechanical properties concrete:

Compression test results:

Seven days of Compression test:

Table X. Compression results for 7days

Weight (g)	Load (KN)	Strength (N/mm^2)
8342	1450	64.44
8390	1480	65.77
8425	1460	64.88

Twenty Eight days Compression test:

Table.XI Compression results for 28days

AGE	Depth in mm
28 days	15
56 days	9

Fifty-six days Compression test:

Table.XII Compression results for 28days

Weight (g)	Load (KN)	Strength (N/mm^2)
8500	1750	77.77
8490	1810	80.44
8390	1830	81.33

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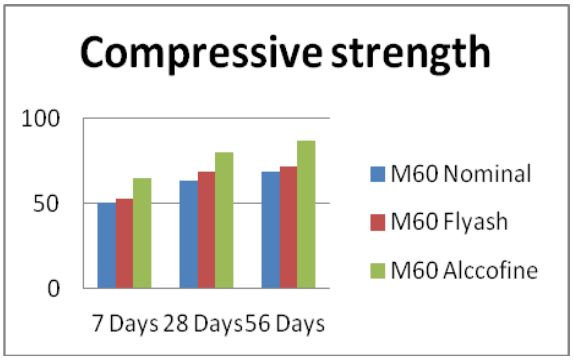
Comparison between the compressive strengths of Nominal concrete, Concrete with the replacement of Fly ash, and concrete with replacement of Fly ash and Alccofine.

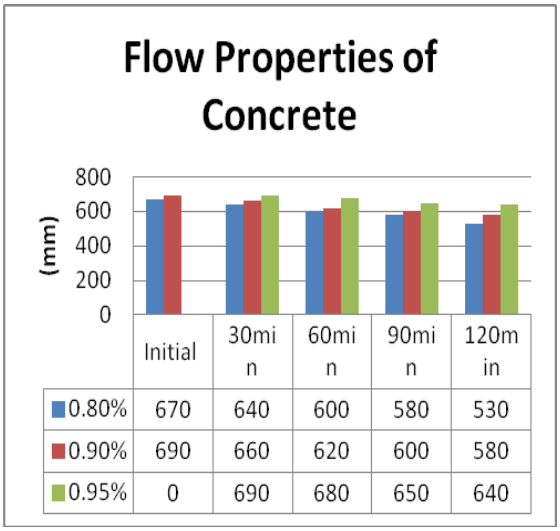


Tests on durability properties of concrete: Table XIV. WPT Results for 28 days and 56days

Age	Charge Passed(Coulombs)
28 days	589
56 days	476

Rapid Chloride Penetration Test:

Water Penetration Test (WPT):



V. CONCLUSION

- The Concrete Placing temperature is reduced to 25ºC to 27ºC from the 35ºC to 37ºC by using the chilled water at 5ºC to 7ºC at the time of mixing the concrete and thus can reduce the Thermal cracks in the concrete.
- The obtained flow properties of the concrete by adding super plasticizer 0.90% made the concrete Self- compacting, and the flow properties remain for 120 min from the time of mixing which can be placed without any segregation in the places where the congested reinforcement is available.
- The Mechanical and the Durability properties of the concrete say's that the concrete got properties of high performance which can withstand the chemical attacks and sustain for long periods.

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