International Journal of Research in Engineering, Science and Management
Volume-1, Issue-5, May 2018
www.ijresm.com

Use of Calcite and Fly Ash for Manufacturing of Self Compacting Concrete

Saurabh D. Lakhamapure[1], Swapnil R. Satone[2], Vivek Naik[3]
[1]*M. Tech. Student, Department of Civil Engineering, KDKCE, Nagpur, India*
[2]*Assistant Professor, Department of Civil Engineering, KDKCE, Nagpur, India*
[3]*Managing Director, Apple Chemie India Pvt. Ltd., Nagpur, India*

***Abstract*—Self-Compacting Concrete is the high performance concrete that is also known as self-consolidating concrete. This is because of it has property likes highly flowable, non-segregating concrete that spreads into place, fills formwork, and compresses even the most congested reinforcement, all without any mechanical vibration. The powder content present in the self-compacting concrete is relatively higher than the other type of concrete and also fine aggregate to course aggregate ratio is more in it. Fly ash is waste material get from thermal power plant after the burning of coal and is collected by electrostatic precipitation. High fineness, good reactivity, low carbon content are essence of good ash. Fly ash particle increase the flowability and reduces the water demand. Calcium carbonate is naturally inorganic material widely available in the form limestone, chalk or marble. Calcium carbonate is the filler material improves the hydration rate of cement compound and consequently increase the strength at early ages. Calcite affect not only the permeability of concrete but also the chemical structure of paste in concrete. In this project there is replace of cement with fly ash and calcite at some percentage and testing of fresh and hardened concrete is done.**

Index Terms—calcite, fly ash, self-compacting concrete

I. Introduction

Self-Compacting Concrete is the high performance concrete that is also known as self-consolidating concrete. This is because of it has property likes highly flowable, non-segregating concrete that spreads into place, fills formwork, and compresses even the most congested reinforcement, all without any mechanical vibration. It is defined as a concrete mix that can be placed only by means of its own weight, with little or no vibration. Self-Compacting Concrete had significant impact on the concrete construction industry. As a high-performance concrete, Self-Compacting Concrete delivers these attractive benefits while maintaining all of concrete's expected mechanical and durability characteristics. If required, low amount of viscosity modifier can eliminate unwanted bleeding and segregation. The powder content present in the self-compacting concrete is relatively higher than the other type of concrete and also fine aggregate to course aggregate ratio is more in it. In several studies it is seen that use of mineral additives have been widely replace form Ordinary Portland cement in many applications because of its effective properties which include cost-reduction, reduction in heat evolution, decreased permeability, increased chemical resistance and requirement of cement becomes less than other concrete.

Fig. 1. Self-compacting concrete

A. Fly Ash

Fly ash is waste material get from thermal power plant after the burning of coal and is collected by electrostatic precipitation. The use of fly ash as concrete admixture not only to extend technical advantage to the properties of concrete but also contribute to the environmental pollution control. High fineness, good reactivity, low carbon content are essence of good ash. Since fly ash is produced by rapid cooling and solidification of molten ash, a large portion of component comprising fly ash particles are in amorphous state. One of the significant characteristics of fly ash is the spherical form of the particles. This shape of particle increase the flowability and reduces the water demand.

Fig. 2. Fly Ash

B. Calcite

Calcium carbonate is naturally inorganic material widely available in the form limestone, chalk or marble. Calcium carbonate is obtained from its various natural mineral bases by processing and mining. Calcium carbonate powder can also be created from the reaction of carbon dioxide with calcium hydroxide. Calcium carbonate is the filler material improves the hydration rate of cement compound and consequently increase the strength at early ages. It don't have any pozzolonic properties but it react with alumina phases to form calcium monocaboaluminate hydrate (Afm) phase to change in strength of concrete. A beneficial influence of powder calcite on sulphate resistance. Calcite affect not only the permeability of concrete but also the chemical structure of paste in concrete. Calcite control the bleeding of concrete with low cement content and low susceptibility of the lack curing.

Fig. 3. Calcite

II. AIM AND OBJECTIVE

To study the effect of mineral admixture (by varying quantity) on fresh and hardened in concrete.

- Selection of aggregate cement ratio
- Improve workability
- Improve harden properties
- Gain of strength with age

III. CHARACTERISTICS OF MATERIAL

A. Cement

Following are the tested properties of cement

- Standard consistency - 33.00%
- Initial Setting Time - 170 min
- Final Setting Time - 245 min
- Fineness Modulus - 9.95%
- Specific Gravity - 3.15

B. 20mm Aggregate

Following are the tested properties of 20mm Aggregate

- Fineness Modulus – 7.03
- Specific Gravity – 2.93
- Water absorption – 0.48%

C. 10mm Aggregate

Following are the tested properties of 10mm Aggregate

- Fineness Modulus – 7.30
- Specific Gravity – 2.91
- Water absorption – 1.03%

D. Fine Aggregate

Following are the tested properties of Fine Aggregate

- Fineness Modulus – 3.01
- Specific Gravity – 2.57
- Water absorption – 1.13

E. Fly Ash

TABLE I
CHARACTERISTICS OF FLY ASH

Test conducted	Test Result	Requirement as per IS 3812 (part I)-2003
Consistency(%)	27.5	---
Specific gravity	2.2	---
Initial setting time (min.)	55	---
Final setting time (min)	225	---
Soundness test (mm) By Autoclave expansion method (%)	-0.0516	Max. 0.8
Fineness % by weight by sieveing (% retained on 45 micron sieve)	45.55	Not more than 34
Source	Koradi power plant	

F. Calcite

TABLE II
CHARACTERISTICS OF CALCITE

Grade	10 Micron (un-coated)
Appearance	Super fine powder
Colour	Whitw and Bright
Whiteness	97%
Residue (45 Micron Sieve)	0.01%
%CaCO3	99.00%
%MgCO3	0.30%
%Fe2O3	0.01%
%HCL insoluable matter	03 Max.
Moisture	0.5 Max.
Oil absorption (ISO 787/5)	17 g/100g
Ph (10% Soln.)	9

IV. PROCEDURE FOR MIX DESIGN

A procedure for efficiently designing SCC mixes is shown below. It is based on a method developed by Okamura. It is important to appreciate that this method may result in parameters.
The sequence is determined as follow.

a) Defining desired air content:

Air content may generally be set at 1 per cent, or a higher value specified when freeze thaw resistant concrete is to be designed.

b) Determination of coarse aggregate volume:

Coarse aggregate volume is defined by bulk density. Generally coarse aggregate content should be between 50 per cent and 60 per cent. When the volume of coarse aggregate in concrete exceeds a certain limit, the opportunity for collision or contact between coarse aggregate particles increases rapidly and there is an increased risk of blockage when the concrete passes through spaces between steel bars.

The optimum coarse aggregate content depends on the following parameters-

- Maximum aggregate size. The lower the maximum aggregate size, the higher the proportion of coarse aggregate.
- Crushed or rounded aggregates. For rounded aggregates, a higher content can be used than for crushed aggregates.

c) Determination of sand content:

Sand, in the context of this mix composition procedure is defined as all particles larger than 0.125 mm and smaller than 4 mm. Sand content is defined by bulk density. The optimal volume content of sand in the mortar varies between 40 – 50% depending on paste properties.

d) Design of paste composition:

Initially the water powder ratio for zero flow (βp) is determined in the paste, with the chosen proportion of cement and additions. Flow cone tests with water/powder ratios by volume of e.g. 1.1, 1.2, 1.3 and 1.4 are performed with the selected powder composition for typical results. The point of intersection with the y - axis is designated the βp value. This βp value is used mainly for quality control of water demand for new batches of cement and fillers.

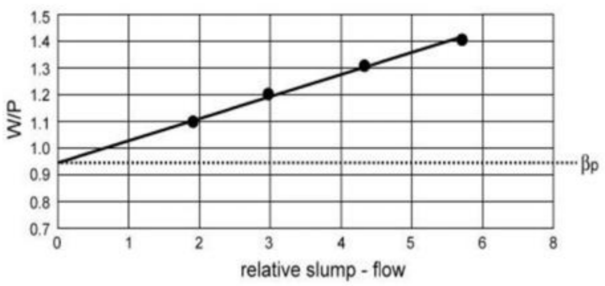


Fig. 4. Relative slump flow

e) Determination of optimum volumetric water/powder ratio and super plasticizer dosage in mortar:

Tests with flow cone and V-Funnel for mortar are performed at varying water/powder ratios in the range of [0.8 – 0.9]. βp and dosages of super plasticizer. The super plasticizer is used to balance the rheology of the paste. The volume content of sand in the mortar remains the same as determined above. Target values are slump flow of 24 to 26 cm and V-Funnel time of 7 to 11 seconds. At target slump flow, where V-funnel time is lower than 7 seconds, then decrease the water/powder ratio. For target slump flow and V-funnel time in excess of 11 seconds, water/powder ratio should be increased. If these criteria cannot be fulfilled, then the particular combination of materials is inadequate. A trial with a different super plasticizer is the preferred alternative.

V. TESTING AND ANALYSIS

Following are the some short for different mixes of concrete.

- Mix A : M-30 grade Self-Compacting Concrete
- Mix B : M-30 grade (Cement replacing by 5% Calcite + 20% fly ash)
- Mix C : M-30 grade (Cement replacing by 10% Calcite + 20% fly ash)
- Mix D : M-30 grade (Cement replacing by 15% Calcite + 20% fly ash)
- Mix E : M-40 grade Self-Compacting Concrete
- Mix F : M-40 grade (Cement replacing by 5% Calcite + 20% fly ash)
- Mix G : M-40 grade (Cement replacing by 10% Calcite + 20% fly ash)
- Mix H : M-40 grade (Cement replacing by 15% Calcite + 20% fly ash)

Workability: Workability is property of freshly mixed concrete or mortar that determines the ease with which it can be mixed, placed, consolidated and finished to a homogenous condition. Following are the

A. Workability Test Result for M30 Grade Concrete

TABLE III
WORKABILITY OF M30 GRADE CONCRETE

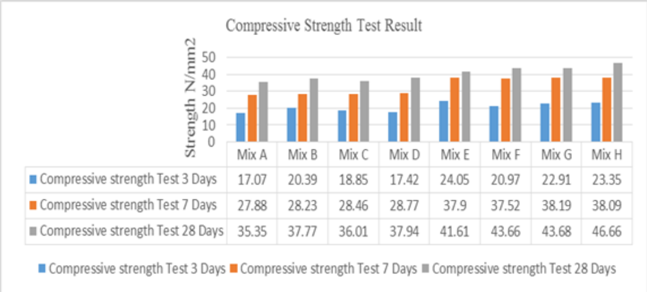
Sr. No.	Workability Test	Mix Designation					Requirement as Per EFNAC	
		Unit	Mix A	Mix B	Mix C	Mix D	Min.	Max.
1	Slump Flow	mm	665	680	690	700	650	800
2	J-ring	mm	6.8	10.6	15.07	18.28	0	25
3	V-funnel	sec.	9.8	10.1	10.1	10.2	8	12
4	L-box	h2/h1	0.85	0.87	0.86	0.9	0.8	1

B. Workability Test Result for M40 Grade Concrete

TABLE IV
WORKABILITY OF M40 GRADE CONCRETE

Sr. No.	Workability Test	Mix Designation					Requirement as Per EFNAC	
		Unit	Mix E	Mix F	Mix G	Mix H	Min.	Max.
1	Slump Flow	mm	670	680	705	720	650	800
2	J-ring	mm	5.2	12	16	19.78	0	25
3	V-funnel	sec.	10.9	11.2	11	11.1	8	12
4	L-box	h2/h1	0.99	0.99	0.99	1	0.8	1

C. Compressive Strength Test Result on Hardened Concrete of Self-compacting Concrete

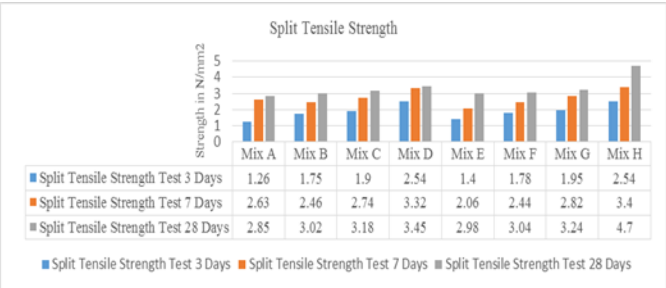


	Mix A	Mix B	Mix C	Mix D	Mix E	Mix F	Mix G	Mix H
Compressive strength Test 3 Days	17.07	20.39	18.85	17.42	24.05	20.97	22.91	23.35
Compressive strength Test 7 Days	27.88	28.23	28.46	28.77	37.9	37.52	38.19	38.09
Compressive strength Test 28 Days	35.35	37.77	36.01	37.94	41.61	43.66	43.68	46.66

Fig. 5. Compressive Strength Test Result of Concrete

Discussion: As per the requirement of IS 456 : 2000 the design strength of concrete is $\pm$ 15% of average.

D. Compressive Strength Test Result on Hardened Concrete of Self-compacting Concrete

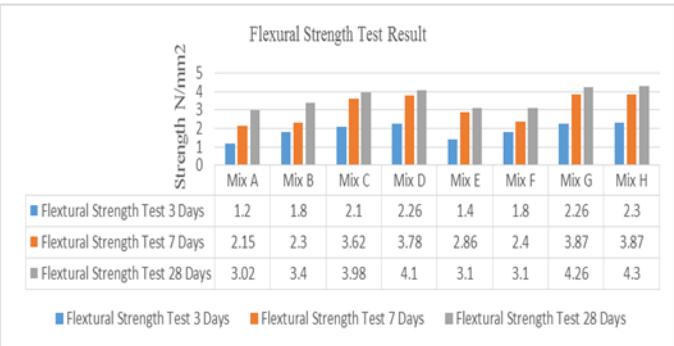


	Mix A	Mix B	Mix C	Mix D	Mix E	Mix F	Mix G	Mix H
Split Tensile Strength Test 3 Days	1.26	1.75	1.9	2.54	1.4	1.78	1.95	2.54
Split Tensile Strength Test 7 Days	2.63	2.46	2.74	3.32	2.06	2.44	2.82	3.4
Split Tensile Strength Test 28 Days	2.85	3.02	3.18	3.45	2.98	3.04	3.24	4.7

Fig. 6. Split tensile Strength Test Result of Concrete

Discussion: As per the requirement of IS code the Split Tensile strength of concrete is 10% of the compressive strength result.

E. Flexural Strength Test Result of Self-compacting Concrete



	Mix A	Mix B	Mix C	Mix D	Mix E	Mix F	Mix G	Mix H
Flextural Strength Test 3 Days	1.2	1.8	2.1	2.26	1.4	1.8	2.26	2.3
Flextural Strength Test 7 Days	2.15	2.3	3.62	3.78	2.86	2.4	3.87	3.87
Flextural Strength Test 28 Days	3.02	3.4	3.98	4.1	3.1	3.1	4.26	4.3

Fig. 7. Flexural Strength Test Result of Concrete

Discussion: As per the requirement of IS code the Flexural Strength of concrete is 10% of the compressive strength result.

VI. CONCLUSION

As the four different self-compacting concrete mix design for M-30 and M-40 grade each are prepared using 20% fly ash and 0%, 5%, 10%, 15% calcite proportions following points are concluded.

- In self-compacting concrete replacement of mineral admixture with cement is increase the powder content in concrete.
- As the increasing percentage of calcite from 0-20 and fly ash constant at 20 percent, the Slump flow test, L-box, V-funnel, J-ring tests of workability for self-compacting concrete are increasing because increase in powder content in concrete.
- The earlier test results of 3 days for all mixes are lower, because of siliceous material present in fly ash that react with calcium hydroxide to form a cement this pozzolonic process takes time to gain strength.
- From an experimental investigation it was observed that compressive strength of Mix-D of M-30 grade and Mix-H of M-40 grade which contain 20% fly ash and 15% calcite gain better strength than any other mix.
- According to tested results for self-compacting concrete of split tensile strength and flexural strength are gradually increase for Mix-D and Mix-H grade which contain 15% calcite and 20% calcite are better than any other mix.

VII. FUTURE SCOPE

The following experiments can be conducted in future with respect to self-compacting concrete.

a) The use of calcite and fly ash in self-compacting concrete for acid attack on concrete.
b) The effect of high temperature on properties of self-compacting concrete containing more than one admixture with calcite.
c) The use of different admixture in self-compacting concrete which help to reduce cost of construction.

REFERENCES

[1] M. S. Shetty, "Concrete Technology Theory & Practice," S. Chand & Co. Ltd., New Delhi.
[2] K. Ozawa, K. Maekawa and H. Okamura, "Development of the High Performance Concrete" in *Proceedings of JSI*, vol. 11, no. 1, pp. 699-704, 1989.
[3] R. Swamy and M. K. M. V. Ratnam, "Effect of Mineral Admixture on Properties of Self Compacting Concrete," in *International Journal for Innovative Research in Science & Technology*, vol. 1, no. 11, pp. 503-511, April 2015.
[4] H. Okamura and M. Ouchi. "Self-Compacting Concrete," in *Journal of Advanced Concrete Technology*, vol. 1, no.1, pp. 5-15, April 2003.
[5] N. Chalhotra, "Properties of Self Compacting Concrete Containing Fly Ash and Silica Fume," Master Thesis, Department of Civil Engineering, Thapar University, 2011.
[6] O. S. Olafusi, A. P. Adewuyi, A. I. Otunla and A. O. Babalola, "Evaluation of Fresh and Hardened Properties of Self-Compacting Concrete," in *Open Journal of Civil Engineering*, vol.5, no. 1, pp. 1-7, February 2015.
[7] IS 12269 - 987 Indian Standard Specification for 53 Grade Ordinary Portland Cement.
[8] IS 456: 2000 Indian Standard Plain and Reinforcement Concrete Code of Practice.
[9] IS 516 - 1959 Indian Standard Method of Test for Strength of Concrete.