Study of Proportinating and Properties of Reactive Powder High Strength Concrete

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Abstract: Reactive Powder Concrete (RPC) is associate ultra-high strength and high ductile material with advanced mechanical properties. Reactive powder concrete may be a concrete while not coarse mixture, however, contains cement, silicon dioxide fume, sand, quartz powder with terribly low tide binder quantitative relation. The absence of coarse mixture was thought of by inventors to be key side for the microstructure and performance of RPC so as to cut back the no uniformity between cement matrix and mixture. was 1st developed, in early 1990, by researchers at Bouygues laboratory in France. The addition of supplementary material, elimination of coarse aggregates, terribly low water/binder quantitative relation, further fine steel fibers, heat action and application of pressure before and through setting were the fundamental ideas on that it had been developed there's a growing use of RPC due to the outstanding mechanical properties and sturdiness. RPC structural components will resist chemical attack, impact loading from vehicles and vessels, and abrupt kinetic loading because of earthquakes. Ultra-high performance is that the most vital characteristic of RPC

***Keywords* — Reactive powder concrete, silica fume, compressive strength, Flexural Strength, bond strength.**

I. Introduction

This dissertation report deals with Methodology through experimental analysis on physical properties and hardened properties of steel fiber reinforced concrete with mineral and chemical admixtures. It is well known that concrete is very good in resisting compressive forces, but it is found to be weak against tensile forces. It has the qualities of flexibility and ability to redistribute stresses, but it possesses a limited ductility and a very little resistance to cracking.

By literature review, the addition of mineral and chemical admixtures to concrete further improves its compressive strength but contribute less to improve its other properties like tensile strength, ductility, resistance to cracking etc. To overcome these use of steel fibers in reinforced concrete works effectively with mineral and chemical admixtures.

The present study aims to carry out reliability analysis of concrete mix with partial replacement of cement by 10%, 20% of fly ash and 5%, 10%, 15% of silica fume including steel fibers of amounting 0.5%, 1.0%, & 1.5% and chemical admixtures with 0.5%, 1.0%, & 1.5% with varying proportions for M35, M50, and M60 grade concrete respectively by considering the material properties. This experimental study would make it possible for a designer to combine the advantages of mineral and chemical admixtures with steel fibers in concrete, like cost reduction, increased strength, increased workability, reduced voids etc. with those of steel fiber reinforcement. The details of experimental study, materials used, and design mix; samples and various tests performed are described as below.

II. METHODOLGY

2. EXPERIMENTAL DETAIL

2.1.Constituents of Reactive Powder Concrete:

2.1.1 Cement:

Cement could be a fine, grey powder. it's mixed with water and material like sand, gravel and crushed stone to form concrete. The cement and water type a paste that binds the opposite materials along because the concrete hardens. the standard cement contains 2 basic ingredients specifically argillaceous and chalky.
In argillaceous materials clay predominates and in chalky materials carbonate predominates within
the gift work fifty-three grade OPC ultratech cement was used for casting cubes and for all concrete mixes. The cement was uniform in color i.e. grey with a light-weight dark-green shade and was free from any arduous lumps. outline of the results of varied tests conducted on cement is provided within the Table 1.

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Table 1: Physical Characteristics of Cement.

Sr. No.	Name of Test	Result
1.	Fineness By dry sieving (%)	1
2.	Consistency (%)	31.25
3.	Setting Time Initial (minutes) Final (minutes)	 90 180
4.	Soundness (mm)	0.8
5	Compressive Strength After a) 3 days (N/mm2) b) 7 days (N/mm2) c) 28 days (N/mm2)	 27.214 33.199 48.620

2.1.2 Fine Aggregate

- **FINENESS MODULUS**=CUMULATIVE WT RETAINED/100

  =352.864/100 =**3.52**

- **SPECIFIC GRAVITY OF NATURAL SAND**

1. Wt. of pycnometer + water= 1438gm
2. Wt. of pycnometer +water+ sample= 2012gm
3. Surface dry weight of sample= 890gm
4. Oven dry weight=876gm

   Specific gravity= 4/ ((3) - (2-1))

   =876/ ((890) - (2012-1438)) =**2.77**

SR NO	SIEVE SIZE	WEIGHT RETAINED	%WT RETAINED	CUMULATIVE WT RETAINED	% PASSING
1	4.75	0.110	10.576	10.576	89.424
2	2.36	0.150	14.423	24.990	75.010
3	1.18	0.250	24.038	49.037	50.963
4	600mic	0.290	27.884	76.921	23.079
5	300mic	0.180	17.307	94.228	5.772
6	150mic	0.030	2.884	97.112	2.888
7	Pan	0.030	2.886	100	0
		=1.04		=352.86	

Table 2: Result of sieve analysis of fine aggregate.

2.1.3. Silica Fume

Silica Fume is a by-product of the manufacture of silicon metal and Ferro-silicon alloys in an electric arc furnace. Silica Fume is a very fine powder consisting of spherical particles or microspheres of mean diameter about 0.15 microns, with a very high surface area (15000-25000m^2/kg) The silica fume used in the present study, silica fume was procured from Oriental Trexim Pvt. Ltd. at Mumbai. The Physical and chemical properties of the silica fume used are reported here for ready reference as obtained from Oriental Trexim Pvt. Ltd. at Mumbai.

Properties		Limits
SiO_2	Silicon Dioxide, Amorphous	min 92%
C	Carbon	max 2.0%
Fe_2O_3	Iron Oxide	max 1.0%
Al_2O_3	Aluminum Oxide	max 1.0%
CaO	Calcium Oxide	max 1.2%
MgO	Magnesium Oxide	max 0.5%
K_2O	Potassium Oxide	max 1.5%
Na_2O	Sodium Oxide	max 0.5%
H_2O	Moisture, as packed	max 2.0%
Loss of Ignition at 975 C		max 3.0%
Coarse Particles >45µm (325 mesh)		max 1.0%
pH value (fresh)		4.5 - 7.5
Bulk Density (as packed)		500 -700 kg/m3 D

Table 3: Technical Specification of Silica Fume.

Fig.1 Silica Fumes

2.1.4.SUPERPLASTICIZER

The very low W/B ratio required for RPC can be achieved with use of super plasticizer (SP) to obtain good workability. In this study, super plasticizer called **Powercrete R62** from polygel industry Mumbai was used. It is an extremely high range water reducing agent which meets the requirements of IS: 9103-1999. The properties of superplasticizer are given in Table 4.

Properties	Power Crete R62
Type of S.P.	Polycarboxylate polymer
Appearance	Dark brown
pH Value	6
Sp. Gravity	1.1
Solid content	40%
Recommended dosage	0.3 to 1.2%

Table 4: Properties of Super plasticizer.

2.2. Experimental Procedure and Results

To study the influence of the constituent materials, 9 different mix proportions are considered by varying water-binder ratio, silica fume and superplasticizer dosage. Cement of quantity 1000 kg/m^3 was kept constant for all

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the mixes. The water-binder ratio of the mixes is varied from 0.2to 0.3. with interval of 0.05. Silica fume was added by 10 to 20 percent with interval of 5 by weight of cement. Superplasticizer dosage varied from 1.5 to 2.5 percent for all the mixes. Detailed mix proportioning and results are mentioned in Table 5.

Sample No.	Normal curing at 27°c		Hot air curing at 150°c for 24 hours	
	Compressive strength at 7th days N/mm²	Compressive strength at 28th days N/mm²	Compressive strength at 7th days N/mm²	Compressive strength at 28th days N/mm²
TM1(1:0.10:1.071)	29.14	53.55	41.45	44.15
TM 2(1:0.10:0.868)	53.66	82.09	79.10	84.24
TM 3(1:0.10:0.758)	51.73	81.12	76.91	83.77
TM 4(1:0.10:0.986)	38.12	55.10	44.68	56.18
TM 5(1:0.10:0.845)	64.48	91.84	84.48	93.16
TM 6(1:0.10:0.70)	63.95	88.15	86.36	88.92
TM 7	45.13	63.14	58.18	63.12
TM 8	70.55	105.81	101.44	108.63
TM 9	68.84	101.17	99.94	102.77
TM 10	63.88	87.43	86.24	92.55
TM 11	58.15	85.12	84.65	91.12
TM 12	64.12	94.11	92.56	101.54
TM 13	68.14	99.45	96.41	105.15
TM 14	63.15	99.45	91.16	102.16
TM 15	69.91	94.77	102.13	109.91

Table 5: Results of Hardened Concrete (i.e. compressive strength)

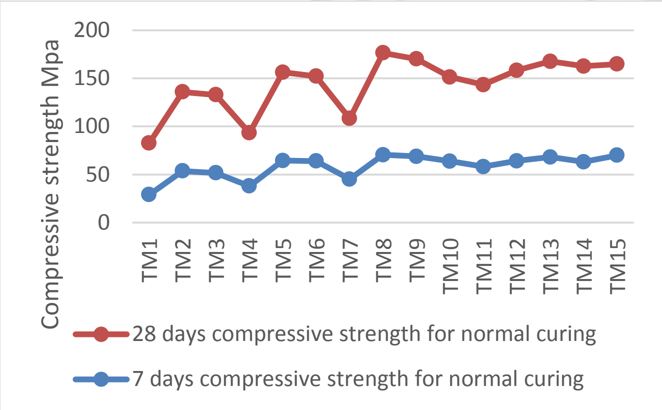

Fig. 2 Compressive Strength of concrete with normal curing.

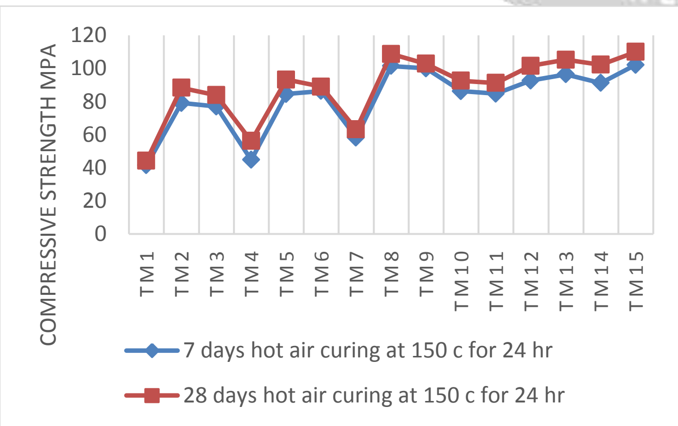

Fig.3 Compressive Strength of Concrete with Hot Air Curing At 150°c for 24 Hrs.

- Strength of trial mixes increases as silica fume percentage increases.
- Highest strength was achieved at 20% of silica fume for mix TM8 and TM 15.
- The strength of concrete cured by hot air method has increased 20 % on 7 days and 10% on 28 days.

III. CONCLUSION

- The high strength concrete is in developing stage.
- High strength concrete of grade M100 is under developing stage.
- The ingredients, their properties and proportioning required for to achieve M100 grade concrete is attempted in this project.
- The concrete with reactive powder is the solution for achieving M100 or more than that grade of concrete.
- Silica fume, quartz powder &fine aggregate less than 600 micron are main constituent of RPC.
- The very fine particles need super plasticizer for mixing and casting. Following are the conclusions drawn from the study carried out in this project.
- Majority of the ingredient are in the powder form which is required to achieve grade of concrete M100.
- Very fine particles (reactive)are needed for high early strength and high strength of concrete.
- The particles smaller than 600micron of any ingredient shall be limited.
- For M100 grade of concrete, the proportion of
- CEMENT (C): SILICAFUMES (S.F): QUARTZ POWDER (Q.P): SAND (S) is presented below.
- The mix TM8 has given highest strength on 7th and 28th day.
- The proportion of TM8 is (C) 1: (S.F) 0.20 :(S) 0.751 with water to binder ratio 0.25 the dosage of super plasticizer is 2%.

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