

Effect of Mineral Admixture on Strength Properties of Roller Compacted Concrete



Engineering

KEYWORDS : Roller Compacted Concrete, Silica fume, Compressive strength, Modulus of Rupture, Split tensile strength.

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ABSTRACT

This paper presents the experimental investigation conducted on silica fume roller compacted concrete (SRCC) to evaluate the compressive strength, split tensile strength and modulus of rupture or flexural strength properties. In the preparation of silica fume roller compacted concrete, cement was replaced at various percentage levels such as 5%, 7.5% and 10% by weight of cement have been added to RCC. Tests were performed to determine workability when RCC is in fresh state and strength properties when RCC is in hardened state. Workability tests like compaction factor test, vee-bee test and slump test were conducted. Strength tests like compression strength, split tensile strength, flexural strength at 3 Days, 7 Days, 28 Days. Experimental investigation revealed that significant increases in strengths were observed in SRCC with increase in silica fume replacement. And workability of concrete was decrease with increase in silica fume.

INTRODUCTION

Roller compacted concrete is a special concrete, compacted by vibratory roller. The methods used to construct roller compacted concrete pavements are very similar to those methods employed in construction of asphalt pavements constructed in various countries. Among the solid wastes the most prominent materials are fly ash, blast furnace slag, rice husk ash, silica fume and materials from construction demolition, substantial energy and cost savings can result when industrial by-products are use as a partial replacement for the energy intensive portland cement. For instance very little improvement has been found with the usage of silica fume in RCCP. By utilizing the silica fume as a pozzolanic material in cement and concrete provides several advantages, such as improved strength and durability properties. The objective of this present investigation is to develop the understanding of the effect of silica fume on RCC mixtures and to prepare recommendations for their appropriate usage. Portland cement was replaced by silica fume at various percentage levels and its effect on the compressive strength, split tensile strength and flexural strength.

Objectives of the experimental work:

- To study the workability of RCC with replacement of silica fume.
- To study the effect of silica fume on mechanical properties of RCCP.

Experimental Programme :

Cement:

The cement used in the present work is Ordinary Portland cement (OPC) of 53 grade, conforming to the requirements of IS: 12269-2014 was used..The cement was tested as per IS 4031-1989. The specific gravity of cement was 3.15.

Fine Aggregate:

Natural river sand confirming to zone-II as per IS-383(1987) was used. The fineness modulus of sand used is 2.64 with a specific gravity of 2.6.

Coarse Aggregate:

The experimental work had crushed granite coarse aggregate confirming to IS 383(1987) was used. Coarse aggregate of size 20mm down having the specific gravity of 2.8 and fineness modulus of 7.20 was used.

Silica Fume:

The silica fume for the present investigation was obtained from M/s ELCOM Enterprises, Mumbai. The silica fume was

sieved and the fraction passing 100µ IS sieve was used in the experiments. The specific gravity of silica fume is 2.2

Chemical admixtures:

In this experimental work sulphonated naphthalene based super plasticizer (SP) was used. The SP used for the study conforms to IS 9103-1999

Water: The water used in RCC mix design was potable and drinking water

Mix proportioning:

Mix proportioning was done using ACI 211.3R-02-2004 specifications based on soil-compaction method which is a soil based approach. The method was developed for RCC pavements of roads and is limited to mix design with maximum NMSA of 19mm (ACI 325.10R-99). The identification of mix proportions and quantity of materials are given in Table2. Table 3 gives the workability of different mixes. The mix was proportioned for specified target of flexural strength of 4.5Mpa.

Table 2: Mix Proportions

Mix	Ce-ment (kg/m ³)	Fine Ag-gregate (kg/m ³)	Coarse Ag-gregate (kg/m ³)	Water (kg/m ³)	w/c ratio
Control mix	295	842	1264	127	0.43

Table 3: RCC Mix Design with Silica Fume

Mix designation	Ce-ment (kg/m ³)	Silica Fume (%)	Silica Fume (kg/m ³)	Sand (kg/m ³)	Coarse Aggregate (kg/m ³)	Water (lit/m ³)	w/b ratio	Compaction factor %	vee-bee Sec	Slump mm
RC C0	295	0	0	842	1264	127	0.43	0.88	18	0
RC C1	250.75	5	12.5	842	1264	127	0.43	0.81	23	0
RC C2	221.25	7.5	16.7	842	1264	127	0.43	0.78	30	0
RC C3	191.75	10	19.1	842	1264	127	0.43	0.72	36	0

4. Casting of Specimens

4.1 Cube Specimens

Cube Specimens were casted for measuring of compressive strength. For each set of concrete cube specimens we used cube mould sizes of 150mm x 150mm x 150mm, concrete is placed and compacted with modified proctor's rammer. After 24 hours, the specimens are demoulded and kept in water for curing

4.2 Prism Specimens

Beam moulds of size 500 x 100x 100 mm size were used for measuring modulus of rupture of RCC. Concrete is placed in beam moulds and compacted with modified proctor's rammer. They were demoulded and kept for curing.

4.3 Cylindrical Specimens

Cylinder moulds of 150mm x 300 mm size were used for measuring split tensile strength.

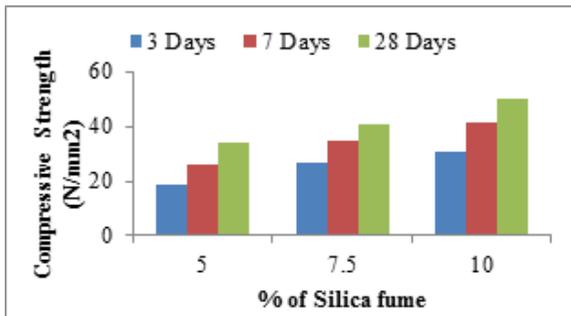
5 Testing and Discussion of Test Results:

5.1 Compressive Strength:

Cubical Specimens of size 150mm x 150mm size were tested under compressive loading at 3 days, 7 days and 28 days. The apparatus had a loading capacity of 300 Ton. The Compressive Strength test results for each of the mix proportion are presented in the Table 4.

Table 4. Compressive Strength Test results :

Silica Fume, %	Fine Aggregate	Compressive Strength (N/mm ²)		
		3 Days	7 Days	28 Days
5	River Sand	18.6	25.7	34.1
7.5	River Sand	26.9	34.4	40.5
10	River Sand	30.8	41.3	50.2

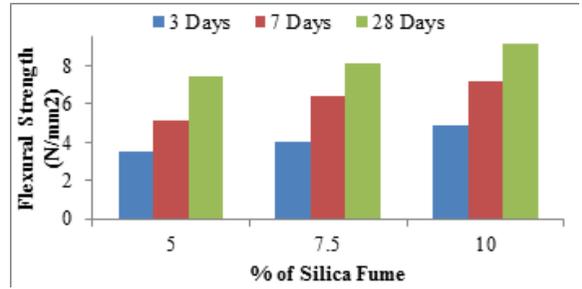


5.2 Flexural Strength:

Prism Specimens of size 500mm x 100mm x 100mm size were tested under flexure center point loading at 3 days, 7 days and 28 days. The UTM apparatus had a loading capacity of 60 Ton. The Flexural Strength test results for each of the mix proportion are presented in the Table 5.

Table 5. Flexural Strength Test results:

Silica Fume	Fine Aggregate	Flexural Strength (N/mm ²)		
		3 Days	7 Days	28 Days
5	River Sand	3.5	5.1	7.4
7.5	River Sand	4	6.4	8.1
10	River Sand	4.9	7.2	9.1

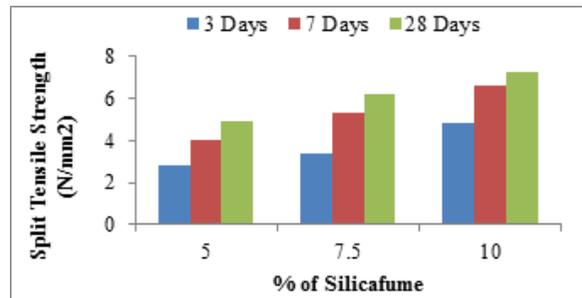


5.3 Split Tensile Strength

Cylindrical Specimens of size 150x 300mm size were tested under split tension loading at 3 days, 7 days and 28 days. The CTM apparatus had a loading capacity of 300 Ton. The Split Tensile Strength test results for each of the mix proportion are presented in the Table 6.

Table6. Split Tensile Strength Test results:

Silica Fume	Split Tensile Strength (N/mm ²)		
	3 Days	7 Days	28 Days
5	2.8	4	4.9
7.5	3.4	5.3	6.2
10	4.8	6.6	7.3



6. CONCLUSION

From the experimental investigation following conclusions were drawn

1. Flexural Strength increases with increase in cement content. At 14%-14.5% of cement content a flexural strength of 4.5 M Pa- 5.0 M Pa was observed.
2. The workability of SRCC is decreased with increase in Silica fume content at all dosages.
3. With increase in silica fume content compressive strength, flexural strength and split tensile strength are increased at all ages.

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