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Effect of Mineral Admixtures and Quartz Sand on Workability and Compressive Strength Of Self Compacting Concrete

Gayathri Komati, Ravi Kumar Garre, Sri Vinay Chowdari Dasari
Department of Civil Engineering, QIS Institute of Technology, Ongole, India
Department of Civil Engineering, QIS of Institute of Technology, Ongole, India
Department of Civil Engineering, Sai Tirumala NVR Engineering College, Narasaraopeta, India
Corresponding Author' Gayathri Komati

---ABSTRACT---
Self-compacting concrete is an advanced concrete over conventional concrete. SCC can be placed in form works with avoiding vibration. SCC is a flowing concrete and is able to consolidate under its own weight. SSC improves the filling capacity of highly congested structural members. The main objective of this investigation is of SCC by using partial pozzolanic admixtures i.e, Quartz powder along with Silica fume and with complete replacement of river sand with Quartz sand. The Experimental work involved in optimization of w/c ratio of concrete to be performed as M50 grade mix for SCC used in this investigation, and for which workability studies and compressive strength tests were done at w/c of 0.30 and 0.34 the mix was designed as per NANSU method. For the w/c ratios of 0.30 and 0.34, the compressive strengths for 28 days were 59.53 N/mm^2 and 60.28 N/mm^2 respectively.
KEYWORDS *– self compacting concrete, Chemical Admixture, Compressive Strength, Workability, W/c ratio, Quartz sand, Slump flow.*

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I INTRODUCTION

1.1 General

Self-consolidating concrete is a highly flow able type of concrete that spreads into the form without the need for mechanical vibration. Self-compacting concrete is a non-segregating concrete that is placed by means of its own weight. The importance of self-compacting concrete is that maintains all concrete's durability and characteristics, meeting expected performance requirements.

In certain instances, the addition of super plasticizers and viscosity modifier are added to the mix, reducing bleeding and segregation. Concrete that segregates loses strength and results in honeycombed areas next to the formwork. A well-designed SCC mix does not segregate, has high deformability and excellent stability characteristics. SCC may be used in pre-cast applications or for concrete placed on site. It can be manufactured in a site batching plant or in a ready mix concrete plant and delivered to site by truck. It can then be placed either by pumping or pouring into horizontal or vertical structures. In designing the mix, the size and the form of the structure, the dimension and density of reinforcement and cover should be taken in consideration. These aspects will all influence the specific requirements for the SCC.

1.2 Properties of Self Compacting Concrete

Current knowledge of these aspects is limited and this is an area requiring further research. Special care should also be taken to begin curing the concrete as early as possible.
The workability of SCC is higher than the highest class of consistence described within EN 206 and can be characterized by the following properties:

1. Filling ability
2. Passing ability
3. Segregation resistance

A concrete mix can only be classified as Self-Compacting Concrete if the requirements for all three characteristics are fulfilled.

1.3 Applications

After the development of the prototype of self – compacting concrete at the University of Tokyo, intensive research was begun in many places, especially in the research institutes of large construction companies. As a result, self – compacting concrete has been used in many practical structures. The first application of self – compacting concrete was in a building in June 1990. Self – compacting concrete was then used in the towers of a pre stressed concrete cable – stayed bridge in 1992. Since then, the use of self-compacting concrete in actual structures has gradually increased. Currently, the main reasons for the employment of self – compacting concrete can be summarized as follows.

1. To shorten construction period
2. To assure compaction in the structure: especially in confined zones where vibrating compaction is difficult.
3. To eliminate noise due to vibration: especially at concrete products plants.

The production of self-compacting concrete as a percentage of Japanese ready mixed concrete, which accounts for 70% of total concrete production in Japan, is only 0.1%. The current status of self-compacting is special concrete rather than standard concrete.

Other applications of self-compacting concrete are summarized below:

1. Bridge (anchorage, arch, beam, girder, tower, pier, joint between beam and girder)
2. Box culvert
3. Building concrete filled steel column
4. Tunnel (lining, immersed tunnel and fill of survey tunnel)
5. Dam (concrete around structure)
6. Concrete products (blocks, culvert, wall, water tank, slab and segment) diaphragm wall
7. Tank (side wall, joint between side wall and slab)

Fire proof

II EXPERIMENTAL METHODOLOGY

2.1 Materials Used

For the present study work, we were used the following materials for preparing self-compacted concrete:

i Ordinary Portland Cement
ii Quartz sand as fine aggregate
iii Crushed stones as coarse aggregate
iv Quartz powder and silica fume as mineral admixtures
v Fair flo as chemical admixture

2.2 Mix Design

Mix design of M50 GRADE, design as per IS10262:2009 and IS 456:2000. Mix proportions for self-compacting concrete of m50 grade were as followed:

With w/c =0.30

Cement=527kg/m^3
Water=158 kg/m^3
Fine aggregates (Quartz sand) = 612 kg/m^3
Coarse aggregates=992 kg/m^3
Quartz powder= 158 kg/m^3
Silica fume=63 kg/m^3
Chemical admixture (fair flo) =6.324 kg/m^3

With w/c=0.34

Cement=476 kg/m^3
Water=162 kg/m^3
Fine aggregates (Quartz sand) = 621 kg/m^3
Coarse aggregates=1050 kg/m^3
Quartz powder= 143 kg/m^3
Silica fume=57 kg/m^3
Chemical admixture (fair flo) =5.712 kg/m^3

2.3 Casting of Test Specimens

For calculating both compressive strength and flexural strength of the mixes at 7 and 28 days both cubes and beams are prepared. The dimensions of cube moulds are 150x150x150 mm^3 are adopted. Further remolding is done after 24 hours and the cubes and prisms are kept for curing under room temperature. Testing is done for both 7 days and 28 days.

2.4 Tests Conducted
The following tests were conducted on the prepared self-compacted concrete specimens:
Tests on fresh SCC
- Slump flow
- L – Box test
- V – Funnel test
- U– Box test

Tests on hardened SCC
- Compressive strength test

III RESULTS AND DISCUSSIONS

3.2 Workability Studies
To estimate the workability of the mixed concrete as per the mix design, we were conducted the particular tests at Materials testing lab at QIS Institute of Technology. The tests were: slump flow test, L-box test, U-funnel test and U-box test. The results of those tests were tabulated as **table-1, table-2, table-3** and **table-4** respectively. And the comparing statements of those results with the acceptable criteria for Self-compacting concrete were tabulated in **table-5**.

Table-1 Slump flow test results

W/C Ratio	0.30	0.34
Spread diameter (mm)	440	510

Table-2 L-Box Test results

W/C Ratio	0.30	0.34
L- box passing (sec)	0.66	0.78

Table-3 V-funnel Test Results

W/C Ratio	0.30	0.34
V-Funnel passing time(sec)	18.8	12.0

Table-4 U-Box Test Results

W/C Ratio	*0.30*	*0.34*
U-Tube filling height (mm)	*50*	*39*

Table-5 Comparing our result with the acceptance criteria of SCC

S. No.	Name of the test	Minimum Value	Maximum Value	Result obtained	
				W/C 0.30	W/C 0.34
1	Slump flow test	520	900	440	510
2	L- box test	0.8	1	0.66	0.78
3	V- funnel test	6	12	18.8	12
4	U-box test	0	30	50	39

3.2 Compressive Strength tests
To estimate the compressive strength of the hardened concrete for 7 days and 28 days, we were conducted the compressive strength test for casted specimens with two different w/c ratios: 0.30 and 0.34, at Materials testing lab at QIS Institute of Technology. The results of those tests were tabulated as **table-6 and table-7** respectively. And the Comparison of the Compressive Strength for 7 and 28 days for the W/C Ratio of 0.30 & 0.34, were tabulated in **table-8**.

Table-6 Compressive strength Results for 7 and 28 days for W/C=0.30

S. No.	7 days			28 days		
	Load kN	Compressive Strength N/mm^2	Average Compressive Strength N/mm^2	Load kN	Compressive Strength N/mm^2	Average Compressive Strength N/mm^2
1	949.40	42.20	41.75	1339.50	59.53	59.53
2	939.30	41.75		1309.29	58.19	
3	909.00	70.40		1369.71	60.88	

Table-7 Compressive strength Results for 7 and 28 days for W/C=0.34

S. No.	7 days			28 days		
	Load kN	Compressive Strength N/mm^2	Average Compressive Strength N/mm^2	Load kN	Compressive Strength N/mm^2	Average Compressive Strength N/mm^2
1	888.80	39.50	40.70	1359.64	60.43	60.28
2	939.30	41.75		1339.50	59.53	
3	919.10	40.85		1369.71	60.88	

Table-8 Comparison of the Compressive Strength for 7 and 28 days for the W/C Ratio of 0.30 & 0.34: -

S. No.	W/C ratio	7 days compressive strength N/mm^2	28 days compressive strength N/mm^2
1	0.30	41.75	59.53
2	0.34	40.70	60.28

IV. CONCLUSION

1. From the workability tests of Slump flow, L-box, V-funnel and U-Box tests, with the super plasticizer of Fair Flo of 1.2% of water.
2. The concrete is not performed as Self-Compacting Concrete (SCC) for the W/C Ratio of 0.30 and increases the workability a little more for the W/B Ratio of 0.34 than the 0.30 but not performed as Self-Compacting Concrete (SCC).
3. This waste is used for dumping for filling the low-lying areas causing the environment in deterioration in long run, so this mix should be used for the construction activity it will reduce the problem of environmental pollution at the same time it reduces the cost of the construction and add it makes the concrete high performing from the durability point of view.
4. For the W/C Ratio of 0.30, the average Compressive Strength for 28 days is 59.53 N/mm2.
5. For the W/C Ratio of 0.34, the average Compressive Strength for 28 days is 60.28 N/mm2.

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