Performance Studies on Mechanical Properties of Self – Compacting Concrete and Self-cured using Super Absorbent Polymer

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Abstract

From past decades many researches are carried out on self-compacting concrete to avoid the vibration in concrete due to many reasons such as to decrease manual work, lack of availability of labours, etc. In this experiment, the study was conducted to study performance on strength and durability characteristics of self-compacting, self-cured concrete. Fly ash is used as filler material and SAP is used as self-curing agent in a various percentages (0.2%, 0.3% & 0.4%) in a weight of cementitious material and also natural sand partially replaced by quarry dust in various percentage (0%, 10%, 20%, 30% & 40%) for M40 grade of concrete. The experiments are carried out by adopting water powder ratio of 0.45, workability tests such as slump flow, V-funnel, L- box tests are conducted as per EFNARC guidelines at fresh state. The mechanical properties such as compressive test, split tensile test were conducted. From the obtained results 0.2% SAP with 10% quarry dust concluded has a optimum dosage for strength properties.
Keywords: Fly Ash, Concrete, Workability, Compressive Strength

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I. INTRODUCTION

A. Self-Compacting Concrete

Construction of durability concrete structure was out most important and to achieve durability or resistance against various climatic calamities the conventional concrete requires higher workability and better compaction in case of dense reinforcement structures, tall structures and high rise structures due to design specification. At the same skilled labors are required. To overcome this difficulties the Self compacting concrete [SCC] concept was proposed in 1986 by Prof Okamura at Ouchi University in Japan.

B. Self-Curing Concrete

Self-curing also known as internal curing. ACI 308 code states that the internal curing in concrete takes place due to the hydration process because of additional of internal water not a part of mixing water. The main aim of internal curing is to enhance the hydration process to maintain the moisture constantly.

II. EXPERIMENTAL METHODS AND RESULTS DISCUSSION

A. Workability

Workability of SCC should ensure better flow-able properties without segregation and bleeding of concrete. Workability properties of SCC is evaluated by conducting slump flow test, V-funnel test, L-box test and T_{50} slump test and results are tabulated below

Table - 1
Workability parameter

Sl. No	*Type of concrete*	*mixes*	*Slump flow (mm)*		*T50 (sec)*	*V- funnel (sec)*	*L-box (h1/h2)*
			Max	*600*	*2*	*6*	*0.8*
			Mini	*800*	*4*	*12*	*1*

1	NSCC	NSCC	700	3	7.9	0.87
2		M1	660	3	7	0.85
3		M2	670	3.6	8	0.87
4	SAP 0.2%	M3	710	3.2	8.8	0.89
5		M4	680	2.9	9.2	0.9
6		M5	675	3	7.5	0.85
7		N1	660	4	7.9	0.88
8		N2	700	2.2	8.0	0.92
9	SAP 0.3%	N3	690	3.2	8.5	0.93
10		N4	665	3.4	7.8	0.90
11		N5	670	2.6	8.2	0.89
12		P1	690	2.3	9.0	0.95
13		P2	670	2.4	9.2	0.92
14	SAP 0.4%	P3	670	2.4	8.5	0.91
15		P4	665	2.6	8.8	0.93
16		P5	670	2.9	8.5	0.9

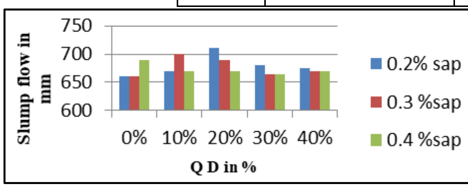

Fig. 1: Slump flow test

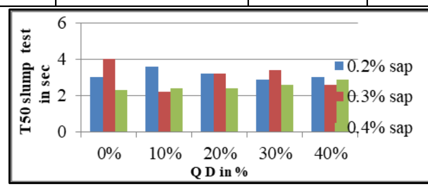

Fig. 2: T_{50} Slump test

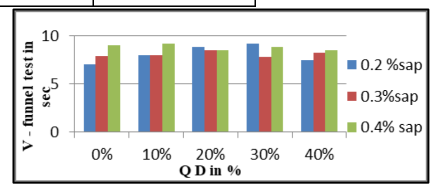

Fig. 3: V - Funnel test

B. Compressive Test

Compressive strength is the maximum which can sustain without failure for a given solid materials. 7^{th}, 28^{th} and 56^{th} days tests are conducted to determine the compressive strength different sets of cubes

Table - 2
Compressive Strength Results

Sl. No	Type of Concrete	Mixes	Compressive strength in N/mm²			
			7days	14 days	28 days	56 days
1	Control mix	NSCC	29.78	34.36	51.87	53.00
2		M1	29.78	35.21	44.44	46.67
3		M2	32.44	43.47	53.33	54.22
4	SAP 0.2%	M3	29.33	34.78	43.56	44.00
5		M4	28.44	33.82	43.11	43.56
6		M5	27.56	33.16	42.22	43.11
7		N1	30.22	36.33	48.44	49.33
8		N2	30.67	38.12	51.11	52.00
9	SAP 0.3%	N3	28.89	35.46	43.11	44.00
10		N4	28.44	35.17	42.22	43.11
11		N5	28.00	36.47	42.22	43.56
12		P1	28.89	32.13	41.78	42.22
13		P2	29.78	31.98	41.33	41.78
14	SAP 0.4%	P3	28.44	33.46	42.22	43.11
15		P4	28.00	32.06	40.89	42.67
16		P5	27.11	32.19	40.89	41.78

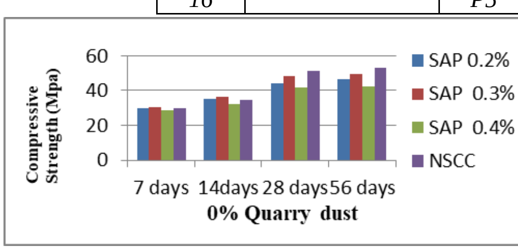

Fig. 4: Compressive Strength of 0% QD

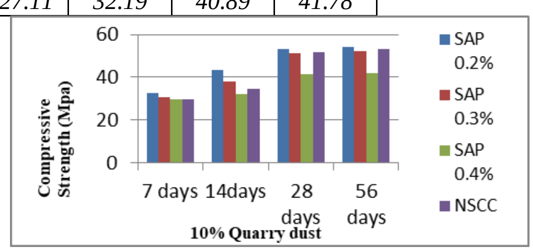

Fig. 5: Compressive strength of 10% QD

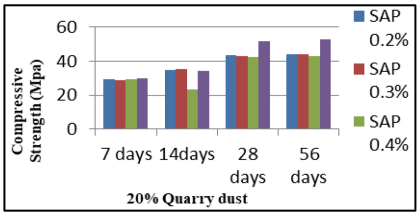

Fig. 6: Compressive strength of 20% QD

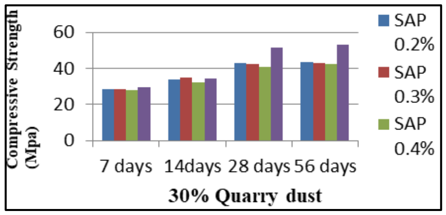

Fig. 7: Compressive strength of 30% QD

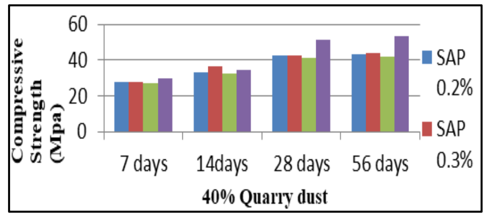

Fig. 8: Compressive strength of 40% QD

From the above results it is observed that 0.2% sap with replacement of natural sand by 10% quarry dust attained higher strength comparing with control mix and different combinations of SAP and quarry dust. By increasing the percentage replacement of quarry dust retrogression in the strength is observed for all the mixes. The compressive strength ratio compared to control mix is 8%, 20.5%, 2.8% and 2.3% higher strength was achieved for 0.2% SAP with 10% quarry dust at 7, 14, 28 and 56 days respectively.

C. Split Tensile Strength

Tensile strength is the property of concrete, due it some other effect and itself loading concreter is highly vulnerable to tensile cracking. The cylinder of size 150mm diameter and 300mm long are casted, test are conducted 7th and 28th days

Table - 3
Split tensile strength results

Type of concrete	*mixes*	*Average of 3 cubes split tensile strength N/mm²*	
		7 days	*28 days*
Control mix	*NSCC*	*2.62*	*4.25*
0.2% sap	*0%*	*2.55*	*4.10*
	10%	*3.11*	*4.46*
	20%	*2.83*	*4.18*
	30%	*2.12*	*4.10*
	40%	*2.19*	*4.03*
0.3% sap	*0%*	*2.48*	*4.18*
	10%	*2.26*	*4.38*
	20%	*2.97*	*4.25*
	30%	*2.41*	*4.18*
	40%	*2.55*	*4.10*
Type of concrete	*mixes*	*Average of 3 cubes split tensile strength N/mm²*	
		7 days	*28 days*
Control mix	*NSCC*	*2.62*	*4.25*
0.4% sap	*0%*	*2.41*	*4.10*
	10%	*2.55*	*4.10*
	20%	*2.55*	*4.18*
	30%	*2.26*	*4.03*
	40%	*2.55*	*4.03*

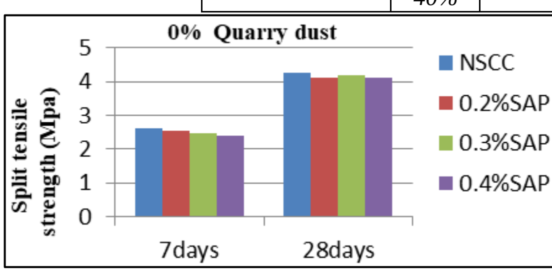

Fig. 9: Split tensile strength of 0% QD

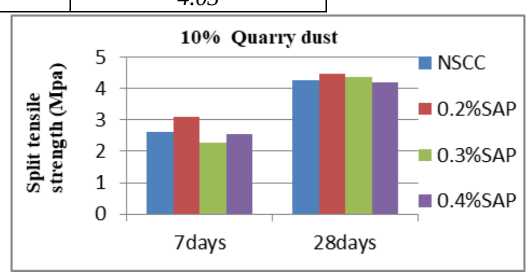

Fig. 10: Split tensile strength of 10% QD

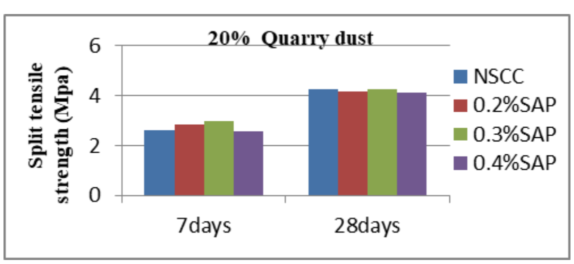

Fig. 11: Split tensile strength of 20% QD

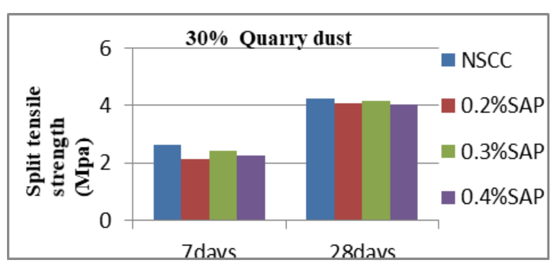

Fig. 12: Split tensile strength of 30% QD

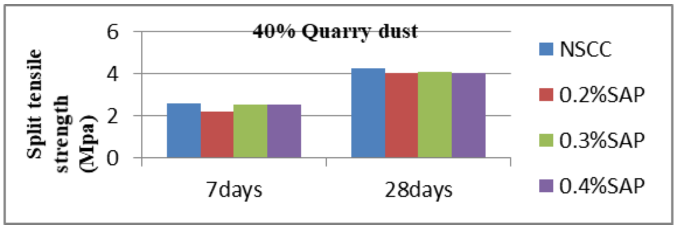

Fig. 13: Split tensile strength of 40% QD

This test is conducted to determine the tensile strength of concrete. The cylinders of size 150mm diameter and 300mm length are casted to determine the split tensile strength. The specimens of age 7 and 28 days are tested and results tabulated in table 5.3. From the tested results it is observed that, the split tensile strength of 0.2% sap with 10% quarry dust was observed that 3.11Mpa and 4.46Mpa for 7 and 28 days respectively. In comparison 18% and 5% increase in the strength is observed for 0.2% sap with 10% quarry dust. The higher strength is observed increase in strength is observed from split tensile strength, it may attribute as because of good bondage at the interface of aggregate and cement mortar.

III. Conclusion

The flow properties in fresh state of concrete mix decreased the dosage of super plasticizer with increase in quarry dust replacement. The basic characteristics of flow properties for all Mixes were well within the EFNARC standards and hence these mixes were chosen as successful mixes.

Compressive and split tensile strength tests concluded that for 0.2% SAP sample 10% quarry dust replacement displayed optimum results. Compared to control mix and other combinations.

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