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USE OF POND ASH (WASTE) AS PARTIAL REPLACEMENT TO FINE AGGREGATE IN SELF COMPACTING CONCRETE

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Abstract - *SCC gained wide demand in the construction industries. For the self compacting concrete fresh properties must possess high fluidity, good cohesiveness and better performance. Specially formulated super-plasticizer is used to allow the design of concrete for its free flowing characteristics. In this paper I study the use of a mineral admixture such as Fly ash and Pond ash is used to ensure the required concrete properties. Taken a constant of 30% Fly ash in the mix and Six SCC mixes were prepared by partial substitution of Pond ash to a fine aggregate. Fresh properties & hardened properties of these concrete mixes were determined. The mix design is done at replacement levels of fine aggregate 0 to 100% (at an interval of 20%).*

The fresh properties tests are conducted are T-Slump, T_{500mm}-slump, L-Box, U-Box, V-funnel & V_{5min}-Funnel Test. Up to a 60% replacement all the values are within the limits as per EFNARC guidelines after 60% bleeding and segregation starts. For the Hardened properties, the cubical specimens are casted for compressive strength testing is of size150x150x150 mm and cylindrical specimen for split tensile strength is of size 150x300mm were prepared & cured and their compressive strength at 7, 14 & 28 days and split tensile strength was evaluated at 28days. The strength values are increased up 40% as increase in PA content after the 40% values decreased.

Key Words: SCC (self compacting concrete), FA (fly ash), PA (pond ash), NS (Natural river sand), CA (coarse aggregate), OPC (Ordinary Portland cement), VMA (viscosity modifying agent) & EFNARC (European Federation of National Associations Representing Producers & Application of Specialist Building Products for Concrete).

INTRODUCTION

1.1 General:

The fast growing country like India electricity requirement is more and increasing day by day, to fulfill the need electricity generated by using both renewable and non renewable sources that's are solar energy, wind mills, hydro electric power stations, coal fired power stations etc, as of now power generation from renewable sources like wind mills, solar energy and hydro electric power is less as compared to non renewable sources, that's are thermal power plants and nuclear power plant, but generation of power at short time is possible easily by non renewable sources but power generation by nuclear power plant is not a safe as compared to thermal power plants. From the thermal power plants waste or end product (Coal combustion products) that contains fly ash, PA or bottom ash, cenospheres, conditioned ash & flue gas de-sulfurisation. But a mainly 90% of Coal combustion products contains a FA and PA other products are in small quantity.

1.2 Fly ash and pond ash:

FA and PA is an end product (waste) of thermal power plants, FA is a very finer as compared to PA, FA is classified as two categories i.e. class C & class F based on chemical properties. Coarser and porous material which falls to bottom of furnace is called as bottom or PA then it is transported to ash pond by mix with water, for an easy flow and it will not fly, so it is also known as wet bottom ash. A pond as is crystalline in nature. The FA and PA has pozzolanic properties that's why this type of FA and PA has led to a greater research in utilization in replacement to a cement and fine aggregate by FA and PA.

1.3 Self compacting concrete (SCC):

SCC is a special type of concrete that flows on its own weight and fills the form work without any vibrations; this type of concrete mainly used where form work is congested or construction area is congested and availability of skilled labors is less, mainly the fresh properties of SCC are filling ability, passing ability & segregation resistance. In SCC powder content is high and fine aggregate volume is greater than coarse aggregate volume, usually the fine aggregate volume to a coarse aggregate volume ratio is taken as 60:40, this is because of finer particles should increases the flow property of concrete, if coarser particles increased it blocks the flow of concrete. Addition of super plasticizers is necessary for this type of concrete to increase a flow of concrete and for some cases VMA may be used in concrete to maintain the homogeneity of concrete mix. SCC is acts as environment friendly concrete by reducing the noise pollution and safety of labors is high at site.

2. MATERIALS USED

2.1 CEMENT:

JK cement OPC 43 grade is used. It confirming to IS 12269:1987. Characteristics of cement are tested in the lab are given in below table.

Table Number – 01: Characteristics of Cement

Sl No	Test Conducted	Result	Limits IS:12269-1987
1.	Cement Brand	JK	-
2.	Cement Grade	43, OPC	-
3.	Cement Consistency	32%	Up to 30%
4.	Initial setting time	46 Min	> 30 Min
5.	Final setting time	400 Min	< 600 Min
6.	Comp strength 7 days	27.4 MPa	> 22.40 MPa
7.	Fineness	8.5%	> 10%

2.2 FLY ASH:

The FA used is class-F, Procured from RTPS Shakti Nagar, confirming to specification IS 3812 Part 1 & 2-2003. The properties are tested confirming to IS 1727-1967. It is used as fines (replacement to cement) in SCC which contributes powder content in SCC.

Table Number – 02: Characteristics of Fly Ash

Serial No.	Characteristics	Results
1	Colour	Whitish grey
2	Form	Powder
3	Specific gravity	2.28
4	Moisture	<0.3%
5	Residue on 45 µ sieve (%)	15.6%

2.3 POND ASH:

PA is collected from RTPS Raichur. The properties of which various tests are done confirming to IS 1727-1967.It is used as fines aggregate in replacement with natural river sand in SCC which contributes to powder content in SCC.

Table Number – 03: Characteristics of Fond Ash

Sl No.	Properties	Results
1.	Colour	Grey
2.	Form	Crystalline
3.	Specific gravity	1.99
4.	Water absorption	21%
5.	Residue on 45 µ sieve (%)	78%

2.4 NATURAL RIVERS SAND:

Natural river sand used in our project satisfied to specifications IS: 383-1970 (zone II). Natural river sand is collected from Krishna river bed near to Kadlur, Raichur. The properties of which were tested in CASHUTEC laboratory and are listed in below table.

Table Number–04: Characteristics of Natural River Sand

Sl No.	Properties	Results
1	Specific gravity	2.61
2	Water absorption	5%
3	Shape of fine aggregate	Circular & angular
4	Sieve analysis test	Grading Zone II

2.5 COARSE AGGREGATES:

Coarse aggregate size mainly influences the fresh characteristics of SCC. As maximum size aggregates used in SCC are increased the flow ability& passing ability of concrete decreases and segregation increases, so to achieve good flow ability and passing ability maximum size of coarse aggregates are taken as 10mm. Coarse aggregates used are taken from Guddeballur quarry. The tests are conducted in CASHUTEC laboratory, which is listed in below table.

Table Number – 05: Characteristics of Coarse Aggregate

Sl No.	Characteristics	Results
1.	Shape	Angular
2.	Specific gravity	2.78
3.	Water absorption	0.9%
4.	Sieve Analysis Test	Graded

2.6 SUPER PLASTICIZER:

Super plasticizer is used to reduce the water to powder ratio & increase the workability of the concrete. Poly carboxylic based super plasticizer Master Glenium of BASF chemicals is used. Dosage is fixed as per the guidelines & requirements.

2.7 WATER:

Clean and portable water satisfying to IS 456:2000 is used.

3. METHODOLOGY

The mix proportions of materials were calculated as per EFNARC guidelines. To study the fresh and strength parameters of SCC it is very much important to conduct a certain tests on SCC. SCC can be tested in fresh state as well as in hardened state with different mix proportion of pond ash. The specimens of cubes and cylinders are casted using different percentage of pond ash for different volume fractions. They are cured normally up to 28days and then these specimens are tested.

Fallowing tests conducted with covering all the three criteria of fresh properties.

- T- Slump flow.
- T_{50mm} - Slump flow.
- V - Funnel test.
- U - Box test.
- L - Box test.
- V_{5min} - funnel test.

Fallowing tests conducted with covering the criteria of hardened properties.

- Compressive strength test.
- Split tensile strength test.
- Water absorption test.

4. RESULTS

RESULTS ON FRESH PROPERTIES OF SCC

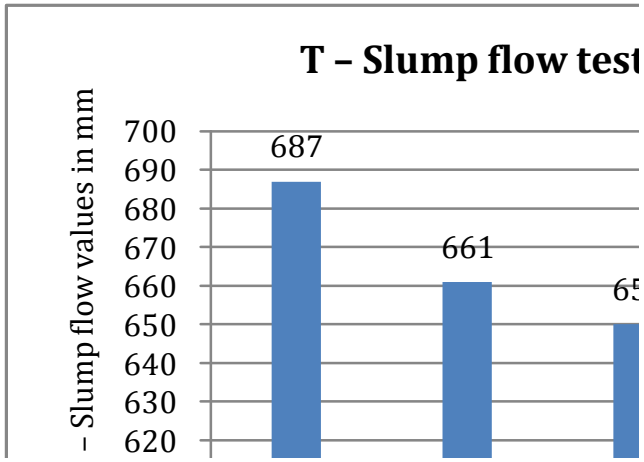
4.1 T - Slump flow test:

This test is used to know the workability criteria of SCC. The result of this test shows that the concrete is having good filling ability up to a 60% replacement after that segregation starts. The values go on decreasing with an increase in the PA content.

The values of T-slump test are shown in the below table with a graph.

Table Number – 6: T – Slump flow test values

Sl No	Concrete designation	T – Slump flow value	Limiting values	
			Minimum	Maximum
1	SCC00	687 mm	650mm	800mm
2	SCC20	661 mm		
3	SCC40	650 mm		
4	SCC60	640 mm		
5	SCC80	---		
6	SCC100	---		



Graph No 01: T – Slump Flow Test.

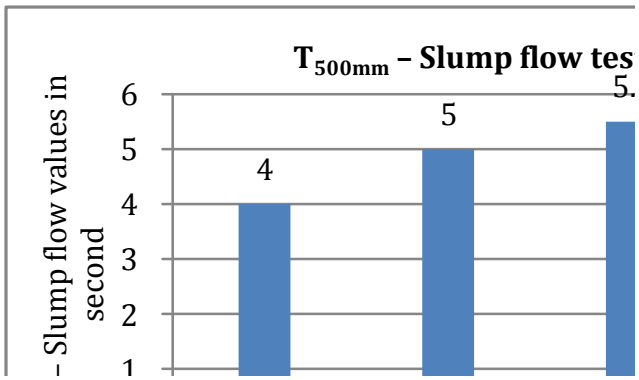
4.2 T_{500mm} - Slump flow test:

This test is conducted to know the workability criteria, one of that is filling ability of SCC. The results obtained are tabulated in below table.

The values of T_{500mm}-slump test are shown in below table with a graph.

Table Number – 7: T_{500mm} – Slump flow test values

Sl No.	Concrete designation	T_{500mm} – Slump flow value (in sec)	Limiting values	
			Minimum	Maximum
1	SCC00	4	2 sec	5 sec
2	SCC20	5		
3	SCC40	5.5		
4	SCC60	4		
5	SCC80	---		
6	SCC100	---		



Graph No 02: T_{500mm}– Slump Flow Test.

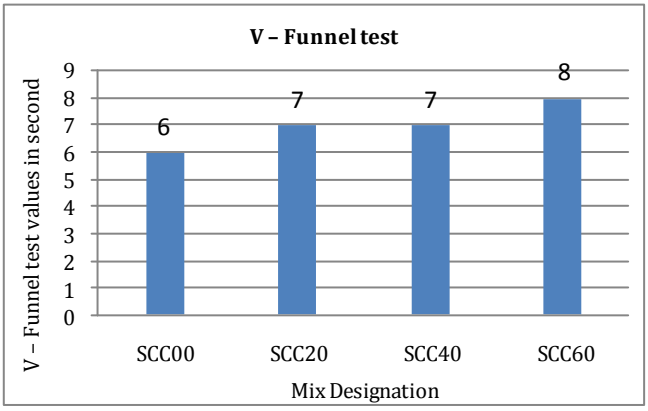
The results of this test show that, the concretes are having good filling ability; the values are goes on increasing up to SCC40 after that starts decreasing.

4.3 V - Funnel test.

This test is conducted on SCC to know the workability criteria. The test result is tabulated in below table.

Table Number – 8: V – Funnel test values

Sl No	Concrete designation	V – Funnel (sec)	Limiting values	
			Minimum	Maximum
1	SCC00	6	6 sec	12 sec
2	SCC20	7		
3	SCC40	7		
4	SCC60	8		
5	SCC80	---		
6	SCC100	---		



Graph No 03: V – Funnel Test.

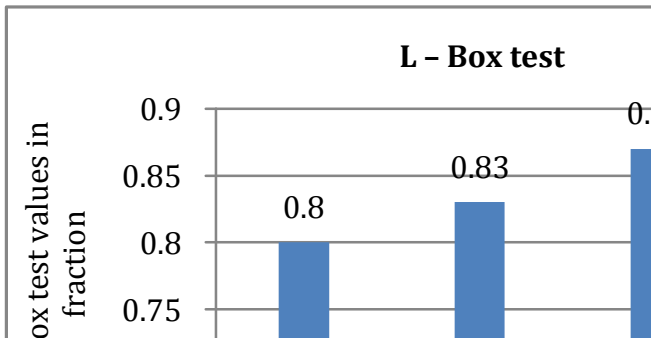
The results of this test show that, the concretes having good filling ability (EFNARC guidelines) up to a SCC60 replacement. After SCC60 the segregation and bleeding started.

4.4 L - Box test.

This test is used to know the workability criteria, in that passing ability. The obtained test results are tabulated in below table.

Table Number – 9: L – Box test values

Serial No.	Concrete designation	L – Box test value	Limiting values	
			Minimum	Maximum
1	SCC00	0.80	0.8	1.0
2	SCC20	0.83		
3	SCC40	0.87		
4	SCC60	0.77		
5	SCC80	---		
6	SCC100	---		



Graph No 04: L – Box Test.

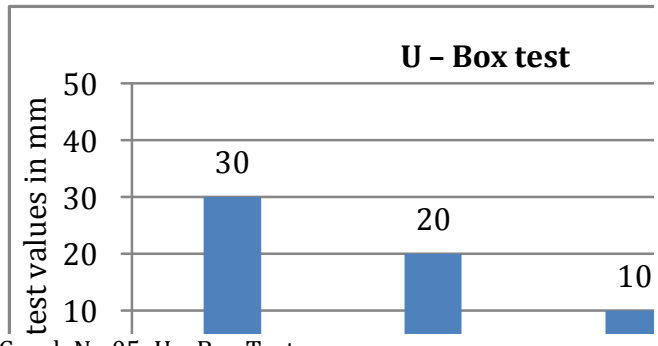
The result of L-box test shows a SCC is having a good passing ability all the obtained values are within the limit up to SCC60 after SCC60 the bleeding and segregation starts.

4.5 U - Box test.

This test is used on SCC to know the workability criteria; one of them is passing ability. The test result obtained is tabulated in below table.

Table Number – 10: U – Box test values

Sl No.	Concrete designation	U – Box test value	Limiting values	
			Minimum	Maximum
1	SCC00	30 mm	0 mm	30 mm
2	SCC20	20 mm		
3	SCC40	10 mm		
4	SCC60	40 mm		
5	SCC80	---		
6	SCC100	---		



Graph No 05: U – Box Test.

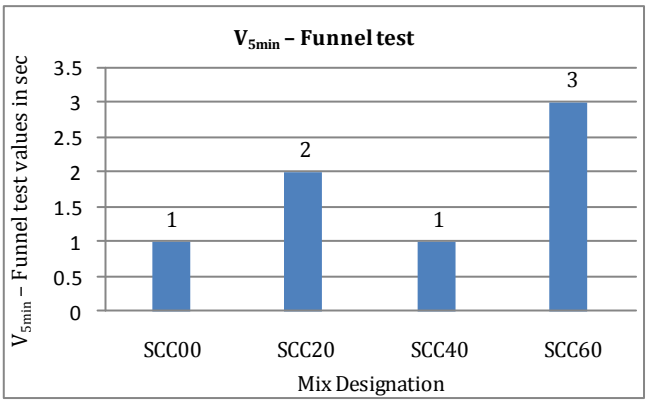
The result of U-box test shows a SCC is having a good passing ability; the results are decreasing up to the 40% replacement after that the result is increased and after 60 % replacement the concrete starts bleeding and segregation.

4.6 V_{5min} - Funnel test.

V_{5min} - Funnel test is conducted on concrete to know the workability criteria; one of them is segregation ability of SCC which is tested for experiment. The test results are tabulated in the below table.

Table Number – 11: V_{5min} – Funnel test values

V_{5min} – Funnel test				
Sl No	Concrete designation	V_{5min} -Funnel test (sec)	Limiting values	
			Min	Max
1	SCC00	(7-6) = 1	0 sec	+3 sec
2	SCC20	(9-7) = 2		
3	SCC40	(8-7) = 1		
4	SCC60	(11-8) = 3		
5	SCC80	---		
6	SCC100	---		



Graph No 06: V_{5min} – Funnel Test.

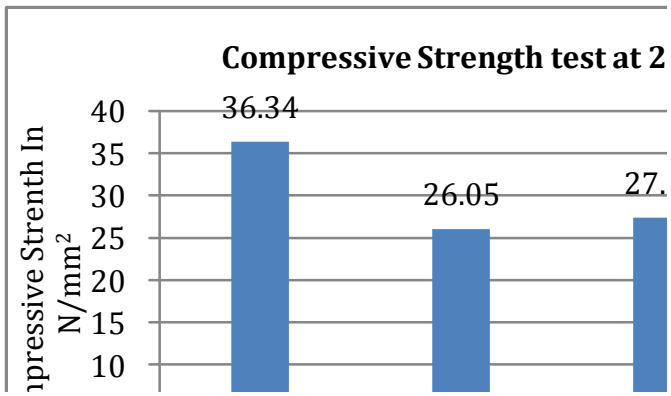
The result of V_{5min} - Funnel test shows that a SCC is having good segregation resistance ability (as per EFNARC) up to the 60% replacement after that the concrete get starts bleeding and segregation.

4.7 Compressive Strength Test.

The Compressive strength Test results will be comparing with the controlled SCC (0% replacement), the values and graphs are shown below.

Table Number – 12: Compressive strength test

Sl No	Conc. designation	Comp strength test ultimate load(N)				
		Cube 01	Cube 02	Cube 03	Average of 3	Strength
1	SCC00	820	818	815	817.6	36.34
2	SCC20	581	588	590	586.3	26.05
3	SCC40	620	618	609	615.6	27.36
4	SCC60	480	492	496	489.3	21.75
5	SCC80	---	---	---	---	---
6	SCC100	---	---	---	---	---



Graph No 07: Compressive Strength test at 28 Days.

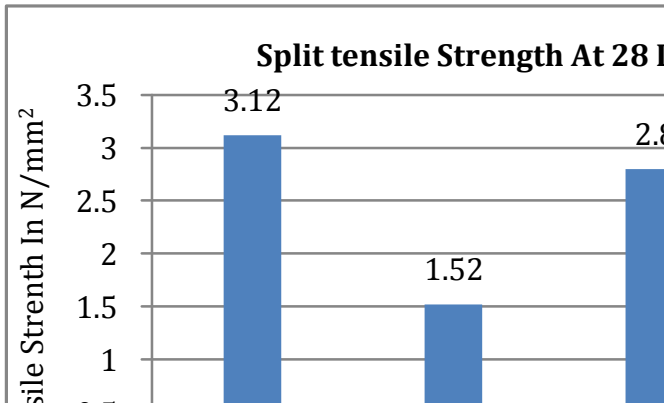
The compressive strengths of cubes specimens for SCC with 0% replacement is higher i.e. 36.34MPa, compared to PA replaced SCC in all the proportions. The strength values are increasing with increase in a volume of PA up to a 40% replacement i.e. 27.36MPa, and after that values get decreased at 28 days strength.

4.8 Split tensile strength test.

The obtained strength Test values will be comparing with a controlled SCC (of 0% replacement), the results & graphs are shown in below.

Table Number – 13: Split tensile strength test values

Sl No	Concrete designation	Split tensile strength (Mpa) @ 28 days			
		Cube 01	Cube 02	Cube 01	Average of 3
1	SCC00	3.11	3.15	3.08	3.12
2	SCC20	1.55	1.52	1.48	1.52
3	SCC40	2.84	2.78	2.77	2.80
4	SCC60	1.99	2.09	2.02	2.03
5	SCC80	---	---	---	---
6	SCC100	---	---	---	---



Graph No 08: Split Tensile Strength At 28 Days.

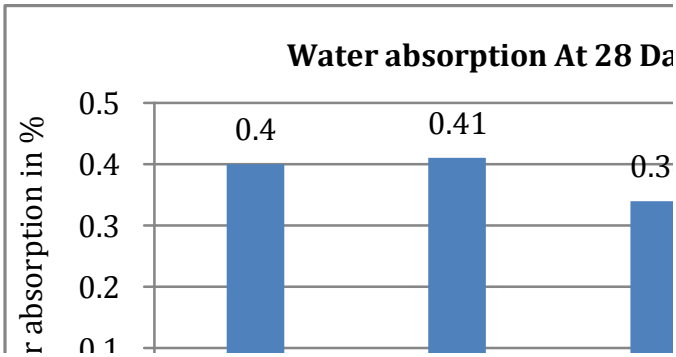
The split tensile strength of cylindrical specimen of an SCC00 is higher i.e. 3.12MPa compared to PA replaced SCCs. The split tensile strength values are increasing with an increment in volume of PA up to 40% (SCC40) replacement, the higher value is 2.80MPa at SCC40 after this, values are be decreasing.

4.9 Water absorption test.

This test is conducted to know the amount of water rise in the concrete through capillary pores, the obtained water absorption Test results will be showing below. The results & graphs are shown below.

Table Number – 14: Water absorption test values

Sl No	Concrete designation	Water absorbed (in %) at 28 days			
		Cube 01	Cube 02	Cube 03	Average of 3
1	SCC00	0.30	0.52	0.39	0.40
2	SCC20	0.41	0.28	0.55	0.41
3	SCC40	0.29	0.29	0.43	0.34
4	SCC60	0.30	0.45	0.60	0.45
5	SCC80	---	---	---	---
6	SCC100	---	---	---	---



Graph No 09: Water Absorption at 28 Days.

The water absorption of cube specimen SCC60 is higher compared to all other SCC. The lowest water absorption is SCC40. But all values of water absorption are not high.

5. CONCLUSIONS

- The fresh or workability properties of the replacements i.e. SCC00, SCC20, SCC40 & SCC60 are within the limiting values given in an EFNARC guidelines, after the SCC60 (i.e. SCC80 & SCC100) the concrete get starts bleeding and segregation that's why these two mixes are not considered for further experiments.
- Compressive strength of SCC20, SCC40 & SCC60 are 26.05MPa, 27.36MPa & 21.75MPa and Compressive strength of SCC0 is 36.34MPa, the compressive strength of without replacement is high, but in replaced SCC the values increasing up to SCC40 (i.e. 27.36MPa) after that values decreasing.
- Split tensile strength of SCC20, SCC40 & SCC60 are 1.52MPa, 2.80MPa &2.03MPa and Split tensile strength of SCC0 is 3.12MPa, the strength value of without replacement is high, but in replacements the values increasing up to SCC40 (i.e. 2.80MPa) after that the values are decreasing.

- Water absorption of SCC20, SCC40 & SCC60 are 0.41%, 0.34% & 0.45% and water absorption of SCC0 is 0.4%, the water absorption of SCC40 replacement is low i.e. 0.34% as compared to all the SCC, but all the values are best as regards to water absorption.

- From all the results i.e. compressive strength is high at SCC40 (27.36Mpa), split tensile strength is high at SCC40 (2.80MPa) & Water absorption is low at SCC40 (0.34%). We can conclude that go for a 40% replacement of natural sand by PA.

- SCC40 satisfies all M20 grade concrete require value, this is best replacement of SCC as powder content 500kg/m^3 and water content 200kg/m^3.

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