EXPERIMENTAL WORK ON SCC USING POZZOLANIC MATERIALS

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Abstract— *Self-compacting concrete (SCC) is one of the type of concrete which will compact by its own weight. Now a day's, due to the increase in cost of cement and sand it is very much important to think for other materials as a replacement of concrete materials. In this present study an attempt has been made to partial replacement of cement by pozzolanic materials like Rice husk ash, Bagasse ash (10%, 20% and 30%) and sand by quarry dust (30%, 50% and 70%). Fresh property was done for all the replacement and hardened properties were done at 7, 14, 28, 56 and 91 days for compressive strength and 7 and 28 day strength for split and flexural strength.*

1. INTRODUCTION

The main goal of any civil engineer is to minimize the cost of the construction. Rapid increase in construction, leads to the shortage of conventional construction materials. Ordinary Portland cement (OPC) is normally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well known. The amount of carbon dioxide (CO_2) released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. In addition, the extent of energy required to produce OPC is only next to steel and aluminum. India has a major agribusiness sector which has accomplished amazing triumphs throughout the last three and a half decades. Agriculture waste or residue is made up of natural sources such as rice straw, oil palm empty fruit bunch, sugar cane bagasse, coconut shell and others. The quarry dust is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes. Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete.

2. MATERIALS USED AND ITS PROPERTIES

2.1 Cement

Cement is the fine material, which is used as a binding material. There are different types of cement are obtained in the market. Some of them are Ordinary port land cement(OPC), Portland-Pozzolana cement(PPC), Rapid hardening Portland cement, Portland slag cement, and High alumina cement. Generally OPC 43 grade is used for the investigation and construction works.

Table - 1 Tests for Cement

SL.NO	PHYSICAL TEST	RESULT OBTAINED	AS PER IS:8112-1989
1	Fineness (retained on 90µm IS sieve) (%)	7.25	`Up to 10 maximum
2	Normal consistency (%)	32	-
3	Specific gravity of cement	3.04	3 to 3.15
4	Vicat time of setting (minutes) a)Initial setting time b)Final setting time	79 365	30 min- 600 max
5	Soundness of cement(mm)	2	Up to 10 max

2.2 Fine aggregate

For the studies, the river sand of Zone-II is used in all the references. IS: 383-1970 defines the fine aggregates as 7.25particles, which will pass through 4.75mm IS sieve and retained on 150 micron.

Table - 2 Tests for Fine Aggregate

SL NO	PHYSICAL TEST	RESULT OBTAINED	AS PER IS:383-1970
1	Specific gravity of F.A	2.48	2.60 to 2.70
2	Fineness modulus of F.A	3.28	2.20 to 3.20

3	Bulk density of F.A a) Dense state(Kg/m^3) b) Loose state (Kg/m^3)	1620.4 1445.8	- -
4	Absorption capacity of F.A (%)	1.65	Less than 2
5	Surface moisture of F.A (%)	1.3	Less than 2

2.3 Course aggregate

The coarse aggregate is defined as an aggregate most of which is retained on 4.75mm IS sieve. The aggregates are formed due to natural disintegration of rocks or by artificial crushing of the rock or gravels. The common coarse aggregates are crushed stone and gravel. The size of the aggregates generally used was 16 mm downsize.

Table - 3 Tests for Course Aggregate

SL NO	PHYSICAL TEST	RESULTS OBTAINED	AS PER IS:383-1970
1	Specific gravity of C.A	2.608	2.60 to 2.80
2	Bulk density of F.A a)Dense state(Kg/m^3) b)Loose state(Kg/m^3)	1578.3 1393.7	- -
3	Absorption capacity of C.A (%)	0.35	Less than 0.60
4	Surface moisture of C.A (%)	0.15	-

2.4 Water

Generally, tap water is used in this experiment. The water, which is used, should be free from salt. It is very important ingredient in the concrete mass, as it actively participates in a chemical reaction with cement.

2.5 Rice husk ash

The rice husk ash had greyish white colour. RHA was passed through IS 90 micron sieve and this was used for the research.

Table - 4 Tests for Rice Husk Ash

SL .NO	PHYSICAL TEST	RESULTS OBTAINED
1	Specific gravity	2.23
2	Bulk density in kg/m^3	578.05

2.6 Bagasse ash

Bagasse is a sinewy matter that the remaining part, after sugarcane is crushed to extract their juices. It is utilized as a bio fuel and in production of bulb and building materials. Bagasse ash is normally obtained under controlled burning conditions in the boiler of the co-generation process. About 300 million tons of sugarcane is prodused in India, in that 10 million tons of sugarcane remains unused.

Table - 5 Tests for Bagasse Ash

SL .NO	PHYSICAL TEST	RESULTS OBTAINED
1	Specific gravity	2.38
2	Bulk density in kg/m^3	1502

2.7 Quarry dust

Quarry dust comprises of the smaller aggregate particles, so it was sieved and quarry dust passing from 4.75mm IS sieve and retaining on 150 micron IS sieve is used for the replacement of fine aggregate.

Table: 6 Tests for Quarry Dust

SL NO	PHYSICAL TEST	RESULT OBTAINED
1	Specific gravity of QD	2.20
2	Fineness modulus of QD	2.45
3	Bulk density of QD a) Dense state(Kg/m^3) b) Loose state (Kg/m^3)	1740 1495
4	Absorption capacity of QD (%)	1.2
5	Surface moisture of QD (%)	0.2

2.8 Chemical admixture

There are water-soluble components added primarily to control setting and hardening of concrete or to reduce its water requirement. The grouping of chemical admixtures is being done depends on their applications such as super plasticizers, retardants, accelerations, water reducing agents. The admixture used here is *"SIKA VISCOCRETE 5231 NS"*.

3. Results and Discussion

3.1 Trail mixes

Table - 7 Trial mixes

SL.NO	SP (%)	RATIO	SLUMP (mm)
1	0.2	1:1.9778:1.622	290
2	0.2	1:1.9778:1.622	345
3	0.3	1:1.9778:1.622	370
4	0.3	1:1.9778:1.622	420
5	0.3	1:1.9778:1.622	470
6	0.4	1:1.9778:1.622	520
7	0.4	1:1.9778:1.622	545
8	0.4	1:1.9778:1.622	590
9	0.5	1:1.9778:1.622	620
10	0.5	1:1.9778:1.622	645
11	**0.5**	**1:1.9778:1.622**	**651 (Stable)**
12	0.6	1:1.9778:1.622	675 (bleeding)

3.2 Notations for several replacements:

Table – 8 Notations for several replacements

Mix ingredients Replacement	Notation	W/C	Admixture
0%	M1	0.45	0.5
10%RHA & BA, 30%QD	M2	0.51	0.6
10%RHA & BA, 50% QD	M3	0.55	0.6
10%RHA & BA, 70% QD	M4	0.55	0.65
20%RHA & BA, 30%QD	M5	0.6	0.55
20%RHA & BA, 50% QD	M6	0.64	0.6
20%RHA & BA, 70% QD	M7	0.65	0.6
30%RHA & BA, 30% QD	M8	0.625	0.65
30%RHA & BA, 50% QD	M9	0.645	0.7
30%RHA & BA, 70% QD	M10	0.695	0.65

3.3 Fresh properties of SCC:

Table – 9 Fresh properties of SCC

Sl. No	Notation	Slump flow in mm	T_{50CM} SLUMP FLOW IN SEC	J RING DEPTH IN mm	V FUNNEL TIME in sec	L BOX RATIO OF DEPTH
1	M1	651	3	8	12	0.83
2	M2	649	3	8.5	11	0.87
3	M3	610	4	11	13	0.87
4	M4	693	3	8	10	0.93
5	M5	590	4	13	14	0.85
6	M6	645	3	9	10	0.82
7	M7	650	3	10	10	0.89
8	M8	613	4	12	12	0.86
9	M9	654	3	8	11	0.82
10	M10	652	3	9	10	0.80

Discussion

The fresh concrete property is obtained better for M4 i.e. 10% partial replacement of RHA and BA to cement and 70% of quarry dust to fine aggregate when compared to all other replacement as well as 0% replacement.

3.4 Test results on hardened concrete

3.4.1 Compression strength test

Table - 10 Compression strength test

SL NO	Notation	MEAN COMPRESSIVE STRENGTH in Mpa				
		7 DAY	14 DAY	28 DAY	56 DAY	91 DAY
1	M1	27.67	29.56	32.1	40.8	45.33
2	M2	19.47	21.38	24.13	33.11	39.07
3	M3	25.28	27.91	31.6	35.73	37.8
4	M4	20.15	23.20	25.88	30.00	33.08
5	M5	16.42	19.42	22	25.11	27.89
6	M6	15.51	17.42	19.11	24.11	27.26

7	M7	14.8	16.27	17.93	20.51	21.99
8	M8	12.38	13.71	15.20	19.33	21.96
9	M9	9.55	11.15	13.11	17.89	21.14
10	M10	10.55	12.35	14.26	23.22	30.51

Discussion

The compressive strength is increasing from 7 days to 91 days. 28 & 91 days Compressive strength has increased from 0% to 10% replacement of RHA & BA, 50% replacement of QD and then it has reduced for further replacements. Hence 10% replacement for cement and 50% replacement for sand can be taken as optimum replacement in this case.

3.4.2 Split tensile strength test

Table - 11 Split tensile strength

SL NO	NOTATION	MEAN SPLIT TENSILE STRENGTH IN N/MM^2	
		28 DAY	56 DAY
1	M1	2.30	2.65
2	M2	1.97	2.26
3	M3	2.38	3.13
4	M4	2.23	2.55
5	M5	1.89	2.22
6	M6	2.13	2.45
7	M7	2.32	2.73
8	M8	1.67	1.92
9	M9	2.06	2.32
10	M10	1.71	2.22

Discussion

It can be seen that the split tensile strength is increasing from 28 day to 56 day. 28 day split tensile strength has increased from 0% to 10% replacement of RHA & BA, 50% replacement of QD and then it has reduced for further replacements.

3.4.3 Flexural strength test

Table – 12 Flexural strength

SL NO	NOTATION	MEAN FLEXURAL STRENGTH in N/mm^2	
		28 DAY	56 DAY
1	M1	2.48	2.84
2	M2	1.87	2.18
3	M3	2.75	3.19
4	M4	2.42	2.65
5	M5	1.96	2.14
6	M6	2.43	2.61
7	M7	2.51	2.95
8	M8	1.86	2.37
9	M9	2.17	2.42
10	M10	1.85	2.26

Discussion

It can be seen that the flexural strength is increasing from 28 day to 56 day. 28 day flexural strength has increased from 0% to 10% replacement of RHA & BA, 50% replacement of QD and then it has reduced for further replacements. For 20% replacement of RHA and BA it can be seen that has the replacement is increased the split tensile strength is also increased but its value is not more than 10% replacement. Hence 10% replacement for cement and 50% replacement for sand can be taken as optimum replacement in this case.

4. CONCLUSION

i. The fresh concrete property is obtained better for M4 i.e. 10% partial replacement of RHA and BA to cement and 70% of quarry dust to fine aggregate when compared to all other replacement as well as 0% replacement.
ii. The compressive strength of the SCC is obtained maximum for M3 i.e. 10% partial replacement of RHA and BA to cement and 50% of quarry dust to fine aggregate when compared to other replacement for 28 day strength.
iii. The split tensile strength of SCC is obtained maximum for M3 i.e. 10% partial replacement of RHA and BA to cement and 50% to fine aggregate. It is seen that the splitting tensile strength value is more then the 0% replacement of cement and fine aggregate.
iv. The flexural strength of SCC is obtained maximum for M3 i.e. 10% partial replacement of RHA and BA to

cement and 50% to fine aggregate. It is seen that the flexural strength value is more than the 0% replacement of cement and fine aggregate.

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