Vol 5 Issue 5 June 2015

ISSN No : 2230-7850

International Multidisciplinary Research Journal

Indian Streams Research Journal

Welcome to ISRJ

RNI MAHMUL/2011/38595 **ISSN No.2230-7850**

Indian Streams Research Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial board.Readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

International Advisory Board

Editorial Board

Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur - 413 005 Maharashtra, India
Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.isrj.org

International Recognized Double-Blind Peer Reviewed Multidisciplinary Research Journal
Indian Streams Research Journal
ISSN 2230-7850 Impact Factor : 3.1560(UIF)
Volume - 5 | Issue - 5 | June - 2015 Available online at www.isrj.org

A STUDY ON SELF COMPACTING CONCRETE PRODUCED USING BLENDED AND ORDINARY PORTLAND CEMENTS

S.M.Maheshwarappa
Associate Professor, Civil Engineering Department, Siddaganga Institute of Technology, Tumkur, India.

Short Profile

S.M.Maheshwarappa is working as a Associate Professor at Civil Engineering Department, Siddaganga Institute of Technology, Tumkur, India,

Co - Author Details :

Shrishail B Anadinni [2] and Madhuvan S[3]
[2]MPrincipal,Vijaya Vittala Institute of Technology,Bangalore.,
[3] M.Tech Student, Civil Engineering Department, Siddaganga Institute of Technology, Tumkur, India.

ABSTRACT:
OPC is more commonly used for SCC. However, with the growing usage of blended cements and improvement in their quality it's possible to produce SCC with blended cements also. Further, it has been necessary to use one or more Supplementary Cementetious Materials (SCM's) by replacing significant amount of cement for several reasons such as reducing Green house gases, improving the workability as well as durability characteristics. As a result, binder system has become increasing complex to necessitate appropriate choice of compatible admixtures to achieve target workability and strength. The choice of materials has become very important. The paper presents the study of SCC mixes prepared using 3 types of cements OPC, PPC and PSC are discussed. The selection of super plasticizer, mix design and fresh and hardened properties of SCC mixes are carried out. The results are of interest in view of increasing the use of blended cements.

KEYWORDS
Concrete; OPC; Blended cements; Strength-weight, SCC; Super plasticizers; w/c ratio

Article Indexed in :
DOAJ Google Scholar DRJI
BASE EBSCO Open J-Gate

INTRODUCTION :

Concrete is basically a mixture of two components: aggregates and paste. The paste, comprised of Portland cement and water, binds the aggregates into a rocklike mass as the paste hardens because of the chemical reaction of the cement and water. Supplementary Cementetious materials and chemical admixtures may also be included in the paste. The paste constitutes about 25% to 40% of the total volume of concrete; the absolute volume of cement is usually between 7% and 15% and the water between 14% and 21%. Conventional cement concrete mixtures suffer from certain deficiencies. Attempts to overcome these deficiencies have resulted in the development of special concretes like SCC. The characteristic key properties of SCC in fresh state are (1) its superior flow ability, (2) the self dearing ability, (3) its passing ability and (4) a sufficient resistance to segregation. The excellent workability of SCC is greatly influenced by its high powder content and the use of high range water reducing admixtures these allows manufacturing SCC with a reduced volume of fine materials.

OBJECTIVE

•To design of SCC mixes for M30 grade having sand replacement level of 20% with OPC and blended cements separately.
•Based on saturation dosage obtained from paste and mortar studies, SP required for SCC due to the involvement of Coarse aggregate and fly ash was to be estimated.
•Categorize the viscosity and slump flow classes obtained by the SCC mixes according to EFNARC for different applications of SCC.
•To compare fresh and hardened properties of concretes.
•To compare strength efficiency of cements.

Table: - 1 - Properties of Concrete Ingredients

Property	OPC	PPC	PSC	Fly Ash	Sand	Coarse aggregate
Description	43 Grade	-	-	Class F	M-Sand	Crushed granite
Confirming code	IS 8119	IS 1489	IS 455	IS 3812	IS 383	IS 383
Specific gravity	3.15	3.04	2.963	2.2	2.43	2.7
Fineness, m^2/kg	285	300	225	310	-	-
Standard consistency, %	30	33	34	-	-	-
Compressive strength, MPa	45	34	35	-	-	-
Bulk Density, kg/m^3	1610	1430	1520	950	1450	1640
Fineness modulus	-	-	-	-	2.64	6.5
Maximum size of aggregate, mm	-	-	-	-	4.75	20

Details of Experimental work

Mix proportions

Mix design was carried out by method of absolute volumes using EFNARC guide lines are as follows

• The super plasticizer required and its dosage was selected based on compatibility studies carried out using Marsh cone.
• The W/C was kept constant for the 3 types of cement and the water/powder ratio ranged from 0.97 to 1.02 for the 3 types of cements and was in the acceptable range 0.8 to 1.1 as recommended by EFNARC. All the 3 cements were mixed with 20% fly ash which act as a fine
• The fine aggregate and coarse aggregate volume fraction were adjusted starting with 50% of concrete volume. The trail was initially started with 50% fine aggregates and 50% coarse aggregates in total volume of aggregates. The final fine aggregate volume of fraction was 55% which was more than 50% and coarse aggregate fraction which was 45% less than 50% as recommended by EFNARC.
• The trail concrete mix was tested for various Self compatibility requirements such as Slump flow, V-funnel time, J-ring and L-box test.
• The table two shows the final mix proportions adopted for SCC mixes for 3 types of cement.

Table: - 2 - Details of SCC mixes for 3 types of cements

Type of cement	OPC	PPC	PSC
Fly ash content =F/(F+C)	0.20	0.20	0.20
W/C	0.438	0.438	0.438
W/B	0.35	0.35	0.35
Unit content of Ingredients			
C=cement, kg/m^3	400	400	400
F=Fly Ash, kg/m^3	100	100	100
Sand, kg/m^3	890	882	877
Coarse aggregate, kg/m^3	558	552	547
Super Plasticizer, kg/m^3	10	11	12
Water, kg/m^3	175	175	175
Density, kg/m^3	2133	2120	2111
Change in cement, %	-	0	0
Change in sand, %	-	0.9	1.5
Change in coarse aggregate, %	-	1.1	2.0
Change in super plasticizer, %	-	-10	-20
Change in water, %	-	0	0
Change in density, %	-	0.61	1.03
Mix Proportion	1:1.78:1.12:0.35	1:1.76:1.10:0.35	1:1.75:1.10:0.35

Table: - 3 – Typical range of SCC mixes for Self compatibility test

Method	Unit	Typical range of values	
		Minimum	Maximum
Slump flow	mm	650	800
V-funnel	Sec	8	12
T50 slump flow	Sec	2	5
L-box	h/h1	0.8	1
J-ring	mm	0	10

Test results and discussions:

Properties of fresh concrete

Tests on fresh concrete were performed to investigate the various self compacting test requirements for the mixes with different cements. The requirements specified by EFNARC are shown in table - 4. The table 5 – 6 shows the slump flow and flow time characteristics for the SCC mixes with OPC, PPC and PSC for the mixes meeting EFNARC guidelines for different applications.

Table: - 4 - Properties of SCC for various types of application

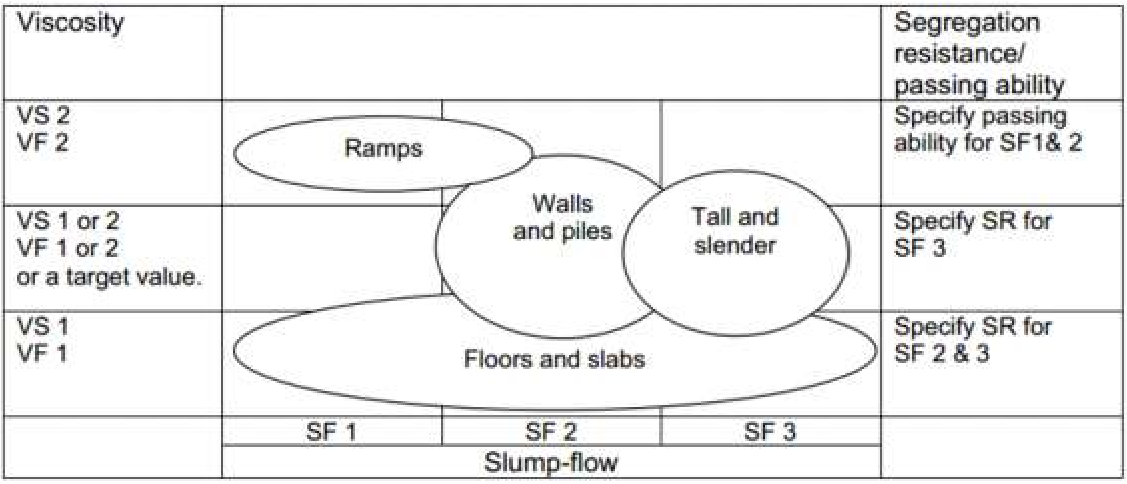

Table: - 5 – Slump - flow characteristics

Class	Slump-flow in mm
SF1	550-650
SF2	660-750
SF3	760-850

Table: - 6 - flow time characteristics

Class	V-funnel time
VF1	= 8
VF2	9-25

Table: - 7 - SCC mix details for OPC

Mix ID	Cement Kg/m^3,	Fly ash, Kg/m^3	CA, Kg/m^3	FA, Kg/m^3	Water, Kg/m^3	SP, %	Slump Flow, mm	V-funnel, sec	Class	Remarks
TR1	400	100	620	809	175	1.6	580	23	SF1/VF2	Not Satisfied
OPC1	400	100	596	842	175	1.8	640	16	SF1/VF2	Not Satisfied
OPC2	400	100	558	890	175	2.0	750	8	SF2/VF1	Satisfied

DISCUSSIONS:

• The mix OPC2 contains 55% of FA by weight of total aggregate and 45% of CA which satisfies the SCC acceptance criteria.
• From table 7, it can be seen that slump flow and viscosity of OPC1 belongs to SF1 and VF2 respectively (refer table 5 and 6).
• The flow and time obtained for the mix SCC2 satisfies EFNARC guidelines belongs class SF2 and VF1 (refer table 5 and 6).

Table: - 8 - SCC mix details for PPC

Mix ID	Cement Kg/m^3,	Fly ash, Kg/m^3	CA, Kg/m^3	FA, Kg/m^3	Water, Kg/m^3	SP, %	Slump Flow, mm	V-funnel, sec	Class	Remarks
TR2	400	100	614	804	175	1.9	540	27	-	Not Satisfied
TR3	400	100	614	803	175	2.1	600	21	SF1/VF2	Not Satisfied
PPC1	400	100	590	835	175	2.1	635	17	SF1/VF2	Not Satisfied
PPC2	400	100	552	882	175	2.2	710	10	SF2/VF2	Satisfied

DISCUSSIONS:

• Initially the mix TR2 was started with 50% of FA by weight of total aggregate and 50% of CA which do not satisfies the EFNARC guidelines.
• Also, mixes TR3 and PPC1 were mixed with 52% of FA and 48% of CA which also does not satisfy guidelines but PPC1 can be classified as classes SF1 and VF2 which is suitable for ramp works (Table - 8).
• The mix PPC2 which satisfies the EFNARC guidelines can be classed as SF2 and VF2 which can be used to floor and slab works (refer table 5 and 6).

Table: - 9 - SCC mix details for PSC

Mix ID	Cement Kg/m^3,	Fly ash, Kg/m^3	CA, Kg/m^3	FA, Kg/m^3	Water, Kg/m^3	SP, %	Slump Flow, mm	V-funnel, sec	Class	Remarks
TR4	400	100	610	799	175	2.1	550	28	SF1	Not Satisfied
TR5	400	100	585	831	175	2.1	570	24	SF1/VF2	Not Satisfied
PSC1	400	100	584	829	175	2.3	620	19	SF1/VF2	Not Satisfied
PSC2	400	100	547	877	175	2.4	685	11	SF2/VF2	Satisfied

DISCUSSIONS:

- The mix TR4 was mixed with 50% of FA by weight of total aggregate and 50% of CA which do not satisfies the EFNARC guidelines.
- The mix TR5 was mixed with 52% of FA by weight of total aggregate and 48% of CA which do not satisfies the EFNARC guidelines.
- The mix PSC1 was a mix with SP dosage of 2.3% and 55% of FA by weight of total aggregate and 45% of CA which satisfies the SCC acceptance criteria.
- The mix PSC1 which satisfies the EFNARC guidelines can be classed as SF1 and VF2 which is used for ramp works (refer table 5 and 6).
- The mix PSC2 was a mix with SP dosage of 2.4% and 55% of FA by weight of total aggregate and 45% of CA which satisfies the SCC acceptance criteria.
- The mix SCC6 which satisfies the EFNARC guidelines can be classed as SF2 and VF2 which can be used to floor and slab works (refer table 5 and 6).

Compressive strength and Split tensile strength:

Compressive strength and Split tensile of concrete was tested using machine of capacity 2000kN for 3, 7 and 28 days for mix proportion shown in table 2.

Fig: - 1

Fig: - 2

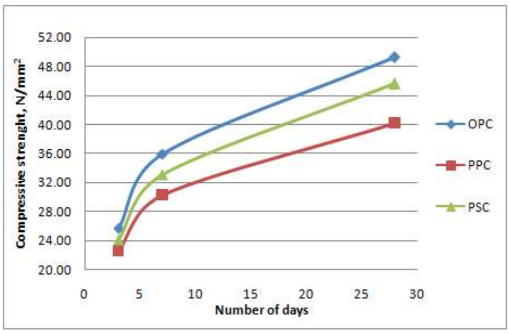

Fig: - 3

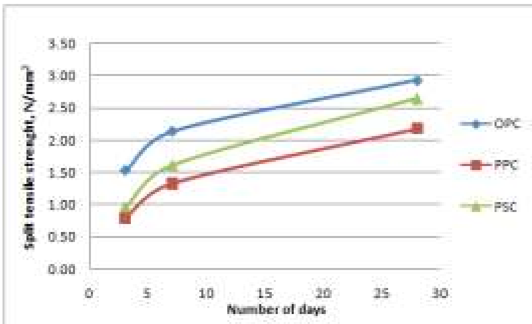

Fig: - 4

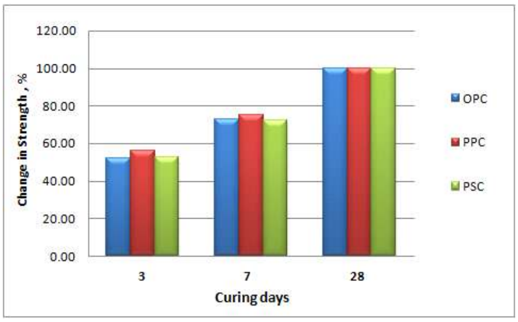

Fig: - 5

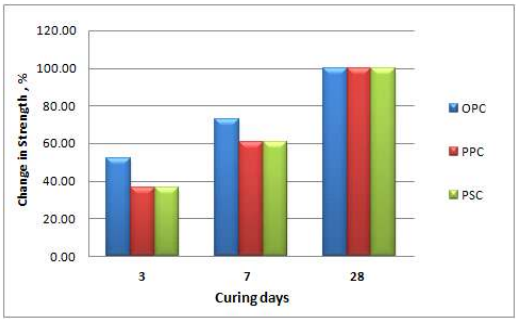

Fig: - 6

Details:

•Fig.1 and Fig.2 shows the experimental setup for Compressive strength and splitting tensile strength for concrete testing respectively.
•Fig.3 and Fig. 4 shows the plot of compressive strength and split tensile strength of different cements with age in days respectively.
•Fig.5 and Fig.6 shows the plot of initial compressive strength and split tensile strength percentage for 3 & 7 days compared to 28 days respectively.

Strength – Weight ratio

The self weight of concrete major portion of load carried by structures such as bridges and multi-storey buildings.Therefore, engineers prefer low density and high strength – weight ratio concrete (SWR). SWR are found for different concretes with different cements by using 28 days strength with below equation and table below shows the values of SWR.

$$\text{SWR} = \frac{\text{Compressive strength}}{\text{Density of concrete}} \text{, Mpa/kg/m}^3$$

Table:- 10 - SWR of different cements

Cement	Strength - Weight ratio of SCC mixes, Mpa/kg/m^3
OPC	0.0231
PPC	0.0190
PSC	0.0216

Strength Efficiency of cement

Strength efficiency of cement (SEC) is computed as ratio of strength to portland cement content , this defines the efficiency of cement to produce strength in the concrete.

$$SEC = \frac{\text{Compressive strength}}{\text{Cement content}}, \text{ Mpa/kg/m}^3$$

Table:- 11 - SEC of SCC mixes

Cement	Strength Efficiency of cement (SEC) of SCC MPa/kg/m^3
OPC	0.1231
PPC	0.1005
PSC	0.1141

CONCLUSIONS

•It is seen from table – 7 among table – 7,8 and 9, that all the SCC mixes prepared for all the 3 types of cements satisfied the EFNARC specifications for SCC's. The OPC based SCC shows lower slump flow (580mm) and V-funnel (23sec) compared to PPC based SCC and PSC based SCC. The use of slightly higher coarse aggregate in case of OPC mixes causes the difference. The PSC based SCC had lowest coarse aggregate and hence the highest workability.
•The super plasticizer dosage required is 2.0% for OPC based SCC's and increased slightly for PPC 2.2% and PSC 2.4% in which PSC based SCC prefers highest Super plasticizer requirement.
•The blended cements required higher super plasticizer content to achieve the target flow workability. The fresh concrete density of SCC mixes range from 2111 to 2133 kg/m3 with OPC registering highest density and PSC showing the highest workability.

REFERENCES

1.EFNARC (European Federation of national trade associations representing producers and applicators of specialist building products), Specification and Guidelines for self- compacting concrete, Hampshire, U.K. (2002)
2.IS 516-1959, Indian Standard code of practice for Methods of tests for strength of concrete, Bureau of Indian Standards, New Delhi (1999).
3.IS: 1489 (Part-1), Indian standard specification for Portland Pozzolana cement Part1 Fly ash based Bureau of Indian Standards, New Delhi, India (1991)
4.Behavior of SCC using PPC with different levels of fly ash P Dinakar etal school of infrastructure, IIT, Bhubaneswar.
5.Development of Self Compacting Concrete by use of Portland Pozzolana Cement, Hydrated Lime and Silica Fume, Dubey Sanjay Kumar and Chandak Rajeev, ISCA Journal of Engineering Sciences, Vol. 1(1), 35-39, July (2012).
6.The European guidelines for SCC specification, guidelines and use MAY 2005.