International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 03 | Mar 2023 www.irjet.net p-ISSN: 2395-0072

Compressive Strength of Different Grades of SCC Mix With 0.5% Of PEG 400 Self Curing Compound

Chamarthy Krishnama Raju[1], Kudumula Sricharan Reddy[2], Varikuntla Tejomahi Paul[3], Mandapati Hari Babu[4], Bommu Subbireddy[5], Atmakuru Vijay Kumar Reddy[6]

[1]Associate Professor, Department of Civil Engineering, Rajeev Gandhi Memorial College of Engineering and Technology (Autonomous), Nandyal, India
[2,3,4,5,6,]Student, Department of Civil Engineering, Rajeev Gandhi Memorial College of Engineering and Technology (Autonomous), Nandyal, India

---

Abstract –*For achieving the desired quality of SCC, proper curing is essential. But in practice achieving proper curing is difficult due to dependency on humans. Also requires water daily during the curing period. Hence researchers are using self curing compound. The effect of Self Curing Compound PEG 400 on compressive strength of different grades of SCC Mix is not investigated as per the literature cited. The present investigation finds the effect of PEG 400 self curing compound on compressive strength of SCC Mixes.*

The Nan-Su mix design is used. The workability properties Slump Flow, J-Ring satisfy EFNARC Guidelines, but V- Funnel and L Box values does not satisfy EFNARC Guidelines. For M25 and M30 grades compressive strength obtained is more than the target mean strength. For all grades compressive strength obtained is more than the characteristic compressive strength of concrete.

Key Words: Self Compacting Concrete (SCC), GGBS, PEG 400 Self Curing Compound, Nan-Su Mix Design, EFNARC Guidelines, Slump Flow Test, J-Ring Test, V-Funnel Test and L-Box Test.

1. INTRODUCTION

For achieving the desired quality of SCC, proper curing is essential. But in practice achieving proper curing is difficult due to dependency on human. Also requires water daily during the curing period. Hence researchers are using self curing compound. The effect of Self Curing Compound on compressive strength of different grades of SCC Mix is not investigated as per the literature cited. The present investigation finds the effect of PEG 400 self curing compound on compressive strength of SCC Mixes.

The Nan-Su mix design is used. Master Glenium SKY 8233 super plasticizer is used. Mix grades M20 to M40 are considered in investigation.

2. EXPERIMENTAL INVESTIGATION

2.1 Materials Used

i. OPC 53 Grade (Zuari company)
ii. GGBS
iii. Fine Aggregate
iv. Coarse Aggregate-12.5 mm(70%) and 20 mm(30%)
v. Master Glenium Sky 8233 (Super Plasticizer)
vi. PEG 400 (Self Curing Compound)

2.11 Materials Properties

The properties of materials are shown in Table 1, 2 & 3.

2.21 Nan-Su Mix Design

The steps used in Nan-Su Mix Design for M35 Grade are given below.

Step 1: Calculation of Coarse and Fine aggregate contents:

$$W_{fa} = PF \times \Upsilon_{fa}\left(\frac{s}{a}\right) \quad = 899.924 \text{ kg/ m}^3 \quad (1)$$

$$W_{ca} = PF \times \Upsilon_{ca}\left(1 - \frac{s}{a}\right) \quad = 739.800 \text{ kg/ m}^3 \quad (2)$$

Where,

W_{fa} : content of fine aggregates in SCC (kg/m^3),
W_{ca} : content of coarse aggregates in SCC (kg/m^3),
Υ_{fa} : unit volume weight of loosely piled saturated surface-dry fine aggregates in air (kg/m^3), = 1545.205 kg/ m^3

Υ_{ca} : unit volume weight of loosely piled saturated surface-dry coarse aggregates in air (kg/m^3), =1376.13 kg/ m^3
PF : Packing Factor= 1.12 (Assumed)
$\frac{s}{a}$: volume ratio of fine aggregates (sand) to total aggregates,
= 52% (Assumed)

Table 1: Properties of Cementitious Materials

Cementitious Material	Specific Gravity Of Cement	Initial Setting Time	Final Setting Time	Standard Consistency	Soundness of Cement	Fineness of Cement
OPC 53 Grade (Zuari Company)	3.145	109 min	395 min	34%	2 mm	3%
GGBS	2.840	> 600 min	-	34%	-	2%
Ranges (Cement)	3.00 – 3.15	> 30 min	< 10 hrs	-		< 10%

Table 2: Properties of Coarse Aggregate (IS: 383-2016)

Properties		Size		Standard range
		20 mm	12.5 mm	
Specific gravity of Coarse Aggregate		2.7		2.5-3.0
Bulk Density of Coarse Aggregate tightly packed (Kg/m^3)		1522.54		-
Bulk Density of Coarse Aggregate loosely packed (Kg/m^3)		1376.13		-
Crushing test		14.30%		
Shape Tests	a) Flakiness Test	14.26 %	16.70%	< 35%
	b) Elongation Test	15.98%	16.92%	< 40%
Impact Test		14.05 %		< 35%
Abrasion Test		14%		<40%

Table 3: Properties of Fine Aggregate (IS: 383-2016)

Properties	Property Value	Standard range
Specific Gravity	2.626	2.5 to 3
Bulk Density, (kg/m^3) Loosely Packed	1545.205	-
Bulk Density, (kg/m^3) Tightly Packed	1626.503	-
Fineness Modulus	3.1 (Zone –I)	2.9 – 3.2 (Coarse Sand)

Table 4: Mix Design of Different Grades of SCC

Grades	Compressive Strength (N/mm²)	W/C Ratio (as per NANSU)	W/P Ratio	SP Dosage(%)	SP Content (Kg/m³)	Water (kg/m³)	PEG 400 (0.5%) kg/m³	Cementitious Materials (Kg/m³)		Fine Aggregate (Kg/m³)	Coarse Aggregate (Kg/m³)		Packing Factor
								Cement	GGBS		12.5mm(70 %)	20 mm(30%)	
M20	20	0.430	0.430	0.8	1.543	204.846	2.391	192.90	285.28	899.924	517.865	221.942	1.12
M25	25	0.415	0.415	0.8	1.833	203.059	2.458	229.16	262.34				
M30	30	0.400	0.400	0.8	2.219	200.393	2.519	277.39	226.37				
M35	35	0.385	0.385	0.8	2.509	197.361	2.579	313.65	202.24				
M40	40	0.370	0.370	0.8	2.799	192.602	2.622	349.91	174.42				

Table 5: Workability Properties

S.NO	Grades of SCC	J Ring Test (mm)	L- Box Test	V- Funnel Test (sec)	V- Funnel T5 (sec)	T50 Slump Flow Test (sec)	Slump Flow Test (mm)
1	M20	19	0.63	14	18	5	650
2	M25	17	0.73	13	17	5	660
3	M30	20	0.75	12	16	4	705
4	M35	16	0.70	14	18	5	700
5	M40	15	0.71	12	17	5	710
EFNARC Guidelines		0-10	0.8-1.0	6-12	+3	2-5	650-800

Step 2: Calculation of Cement Content:

$$C = \frac{f_c'}{20} \quad = 313.649 \text{ kg/ m}^3 \qquad (3)$$

Where,
C= Cement content (kg/m³);
f'_c = designed compressive strength (psi). =6273 psi (43.25 MPa Target Mean Strength Obtained from IS: 10262-2019)

Step 3: Calculation of mixing water content required by cement:

$$W_{wc} = \frac{W}{C} \times C \qquad = 120.755 \text{ kg/ m}^3 \qquad (4)$$

Where,
W_{wc} = water required by cement (kg/m³),
$\frac{W}{C}$= the water/cement ratio = 0.385 (After Trial mixes)

Step 4: Calculation of SP dosage

Dosage of SP used W_{sp} = n% × C (5)
Where,
n% = Dosage of SP = 0.8 % (Fixed after trials)
Amount of water in SP
W_{wsp} = (1-m%)W_{sp} = 1.255 kg/m³ (6)
Where,
m% = Amount of binders and its solid content of SP taken as 50%.

Step 5: Calculation GGBS content:

$$V_{PG} = \left[1 - \left(\frac{W_{ca}}{\Upsilon_W G_{ca}} + \frac{W_{fa}}{\Upsilon_W G_{fa}} + \frac{C}{\Upsilon_W G_c} + \frac{W_w}{\Upsilon_W G_w} + V_a\right)\right] = 0.149\ m^3 \quad (7)$$

Where, Υ_w = density of water,
G_{ca}, G_{fa}, G_c, G_w are specific gravity of coarse aggregates, fine aggregates, Cement, and water respectively,
(W/G) = Water to GGBS ratio(Assumed).
V_a = air content in SCC (%).

The modified formula[2] (8) for calculating W_G is used.

$$V_{PG} = \left[1 + \left(\frac{W}{G}\right) G_G\right] \times \frac{W_G}{\Upsilon_W G_G} \quad (8)$$

Where, G_G, Specific Gravity of GGBS

and $\frac{W}{G}$ = 0.385 is assumed, and V_{PG} obtained from Eq.(7)

W_G = 202.235 kg/m³ (9)

Mixing water content required for GGBS paste is obtained from Eq(10)

$$W_{WG} = \frac{W}{G} \times W_G \quad = 77.860\ kg/m^3 \quad (10)$$

Step 6: Calculation of mixing water content in SCC:

The mixing water needed by SCC is calculated from Eq. (11).

$W_w = W_{wc} + W_{WG} - W_{wsp}$ = 197.361 kg/m³ (11)

Step 7: Calculation of PEG 400 Self Curing Compound:

PEG 400 Self Curing Compound of 0.5% by weight of Cementitious materials is calculated from Es. (12).

W_{PEG} = .005x(C+W_G)=0.005 x(313.649+202.235) = 2.579 kg/m³ (12)

3. MIX DESIGN

Concrete grades M20 to M40 are designed as per above Nan-Su mix design. Target mean strength as per IS 10262:2019 is used for the mixes in Eq. 3 in place of f'_c. Based on trial mixes W/C ratio and SP dosage is fixed to satisfy EFNARC guidelines. The SCC mix proportions for different grades of SCC are shown in Table 4.

4. WORKABILITY TESTS

Slump flow test and then J-Ring test is conducted in order by using 6 litres of concrete. V funnel test is conducted by using 14 litres of concrete. L Box test is conducted by using 17 litres of concrete. Fresh properties are determined for the mixes. The results are as show in Table 5. Slump Flow and T50 Slump Flow results are conforming to EFNARC guidelines for SCC and other results are not confirming to EFNARC guidelines.

5. COMPRESSIVE STRENGTH OF MIXES

The compressive strength of different grades of concrete for 3,7 and 28 days is determined after curing in air at room temperature and the results are shown in Table 6 and also shown in Fig 1. For grades M25 and M30 compressive strength is more than the target mean strength. For all grades the compressive strength obtained is more than the characteristic compressive strength.

Table 6: 3, 7 and 28 Days Compressive Strength of Different Grades of SCC

S.No	Grade of Concrete	Compressive Strength (N/mm²)		
		3 Days	7 days	28 Days
1	M20	19.90	27.46	25.10
2	M25	18.50	30.58	33.47
3	M30	24.92	35.78	40.23
4	M35	23.77	33.86	39.54
5	M40	24.96	34.07	44.11

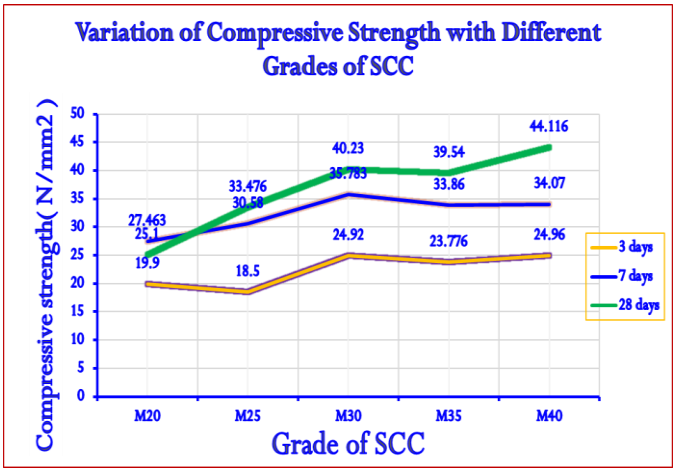

Fig 1. Variation of Compressive Strength with Different Grades of SCC for Ages 3, 7 & 28 days

6. CONCLUSIONS

1. For grades M25 and M30 compressive strength is more than the target mean strength(IS: 10262=2019).

2. For all the grades compressive strength obtained is more than the characteristic compressive strength of concrete.

3. Slump flow and T50 slump flow test results are conforming to EFNARC guidelines for SCC.

REFERENCES

1. C. Krishnama Raju et. al. (2022) investigated on "*Compressive Strength of Different Grades of SCC Mix using Portland Slag Cement (75%), GGBS(25%) and Replacing 20% Fine Aggregate with Copper Slag*" , International Research Journal of Engineering and Technology(IRJET), Vol. 9, Issue 04, April 2022 pp: 3535-3539, p-ISSN:2397-0072.

2. G. Asif Hussain et.al (2020), "Properties of M60 High Performance Self Compacting Concrete by using Blends of Different Sizes of Coarse Aggregate", National Virtutal Conference on Recent Trends in Civil Engineering -2020 (RTCE'20),September 2020 pp 31-36, ISBN: 978-81-942685-2-9.

3. Gajireddy Nandini et. al. (2020), *"An Experimental Study On Physical Properties Of Self Curing Concrete by using Polyethylene Glycol",* International Journal of Research, vol. 07, Issue 02, p-ISSN: 2348-6848.

4. J. Vengadesh Marshall Raman et. al. (2017), "*Partial Replacement of Cement With GGBS in Self Compacting Concrete for Sustainable Construction*", SSRG International Journal of Civil Engineering,(SSRG-IJCE), Vol. 04, Issue.03, March 2017, ISSN: 2348-8352.

5. B. Chandraiah, et. al. (2017) "*Variation Of Compressive Strength And Split Tensile Strength Of M40 Self Compacting Concrete With Different Sizes Of Coarse Aggregate*", International Journal of Engineering Technology Science and Research (IJETSR), Vol. 4, Issue 8, August 2017, pp.279-285

6. Bhavani, et. al. (2016), " *Effect on Mechanical Properties of M25 SCC with Variation of Class - F Fly Ash & GGBS*". International Journal of ChemTech Research, Vol. 11, No. 07, 2018, pp. 70-77, DOI= http://dx.doi.org/10.20902/IJCTR.2018.110709

7. M.V.Jagannadha Kumar et. al. (2012), *"Strength Characterstics Of Self-Curing Concrete",* International Journal of Research in Engineering and Technology, Vol. : 01 Issue: 01, Sep-2012, ISSN: 2319-1163.

8. S. Venkateswara Rao, M.V. Seshagiri Rao, P. Rathish (2010), "Effect of Size of Aggregate and Fines on Standard and High Strength Self Compacting Concrete", Journal of Applied Sciences Research, pp. 433-442.

9. Nan Su, Kung-Chung Hsu and His-Wen Chai (2001) proposed a " *Simple Mix Design Method for Self Compacting Concrete*" Journal of Cement Concrete Research , Vol. 31, No. 12, pp. 1799-1807., Dec. 2001.