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Effect of PEG 400 Self Curing Compound On Compressive Strength of M25 SCC Mix

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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(0% to 2% in steps of 0.5%) on compressive strength of M25 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 M25 SCC Mix.*

IS:10262-2019 mix design is used. The workability properties Slump Flow, satisfy EFNARC Guidelines, but V-Funnel does not satisfy EFNARC Guidelines. For PEG 400 0.5% to 1.5% compressive strength obtained is more than the target mean strength. For PEG 400 0.0% to 2.0% compressive strength obtained is more than the characteristic compressive strength. Compressive strength of mix with 0.5% self curing compound is more than 52% compared to mix with 0% self curing compound.

Key Words: Self Compacting Concrete (SCC), GGBS, PEG 400 Self Curing Compound, EFNARC Guidelines, Slump Flow Test, V-Funnel 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 PEG 400 Self Curing Compound on compressive strength M25 SCC Mix is not investigated [3][6] as per the literature cited. The present investigation finds the effect of PEG 400 self curing compound on compressive strength of M25 SCC Mix.

The IS 10262-2019 mix design is used. Master Glenium SKY 8233 super plasticizer is used. Mix grade M25 SCC considered in investigation.

2. EXPERIMENTAL INVESTIGATION

2.1 Materials Used

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

2.2 Materials Properties

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

2.3 IS 10262-2019 Mix Design

The steps used in Mix Design for M25 Grade are given below.

Step 1: Calculation of Target mean strength:

$$f'_{ck} = \max \begin{Bmatrix} f_{ck} + 1.65\, s \\ f_{ck} + X \end{Bmatrix} = 31.6\ MPa \qquad (1)$$

Where,
$f'_{ck} = Target\ Mean\ Strength$
$f_{ck} = Characteristic\ Compressive\ Strength = 25\ MPa$
s = standard deviation – 4
X = 5.5

Step 2: Approximate Air Content:

From IS: 10262 table 3, the approximate amount of entrapped air is 1% for 20 mm nominal size aggregate.

Table 1: Properties of Cementitious Materials(IS:4031-1988)

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)	3.135	105 min	350 min	33%	1 mm	7%
GGBS	2.852	-	-	-	-	-
Fly Ash	2.240	-	-	-	-	-
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		2.785	2.711	2.5-3.0
Bulk Density of Coarse Aggregate tightly packed (Kg/m^3)		1550.26	1518.51	-
Bulk Density of Coarse Aggregate loosely packed (Kg/m^3)		1385.18	1371.42	-
Crushing test		14.84%		
Shape Tests	a) Flakiness Test	13.26 %	16.80%	< 35%
	b) Elongation Test	11.82%	13.53%	< 40%
Impact Test		14.59 %		< 35%
Abrasion Test		14%		<40%

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

Properties	Property Value	Standard range
Specific Gravity	2.765	2.5 to 3
Bulk Density, (kg/m^3) Loosely Packed	1477.225	-
Bulk Density, (kg/m^3) Tightly Packed	1590.473	-
Fineness Modulus	3.029 (Zone –I)	2.9 – 3.2 (Coarse Sand)

Table 4: Mix Proportions of M25 SCC as per IS: 10262-2019

Mixes	Compressive Strength (N/mm^2)	Self Curing Compound (%)	Self Curing Compound (Kg/m^3)	P Dosage(%)	SP Content (Kg/m^3)	ater (kg/m^3)	W/C Ratio	Cementitious Materials (Kg/m^3)			Fine Aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)	
								Cement (70%)	GGBS (30%)	Fly Ash		12.5mm(70 %)	20 mm(30%)
M1	25	0.0	0.0	1.8	7.80	195	0.45	303.33	130	6.67	952.85	589.82	252.70
M2	25	0.5	2.2	0.5	2.17								
M3	25	1.0	4.4	0.5	2.17								
M4	25	1.5	6.6	0.5	2.17								
M5	25	2.0	8.8	0.5	2.17								

Table 5: Workability Properties

S.NO	Mixes	Self Curing Compound (%)	Slump Flow Test (mm)	V- Funnel Test (sec)
1	M1	0.0	650	29
2	M2	0.5	670	35
3	M3	1.0	660	24
4	M4	1.5	665	18
5	M5	2.0	690	16
EFNARC Guidelines			650-800	6-12

Step 3: Selection of Water- Cement Ratio(W/C):

Maximum water cement ratio for severe condition 0.45(IS: 456-2000). Based on trials W/C = 0.45 is fixed.

Step 4: Selection of Water, Cement and GGBS Content:

Water content should be in range of 150-210 kg/m^3.
Water Content = 195 kg/m^3.
Cement Content = 195 / 0.45 = 433.33 kg/m^3.
Cement (70%) = 433.33x0.7 = 303.33 kg/m^3.
GGBS (30%) = 433.33x0.3 = 130 kg/m^3.

Step 5: Selection of Super Plasticizer (SP):

By slump flow trials super plasticizer content is fixed as 1.8% for mix M1 and 0.5% for mixes M2 to M4.

Weight of SP for M1 mix = 0.018 x 433.33 = 7.80 kg/m^3

Weight of SP for M2 to M5 mixes = 0.005 x 433.33 kg/m^3

Step 6: Selection of Powder and Fine Aggregate Content:

The fines < 0.125 mm in the mix is generally in the range of 400 – 600 kg/m^3
Powder content = 444 kg/m^3. (Assumed)
The fines <0.125 mm in fine aggregate is 0%. This is drawback in IS 10262. Hence assumed 0.7% Fly Ash fines in fine aggregate.
Fines to be contributed by fine aggregate = Powder content – (Cement + GGBS) = 440 – 433.33 = 6.67 kg/m^3

Fine aggregate = 6.67 / 0.007 = 952.85 kg/m^3

Step 7: Selection of Coarse Aggregate Content:

In m^3 of concrete,

$$V_{ca} = 1 - V_a - V_w - V_c - V_G - V_{FA} - V_F - V_{SP} \quad (2)$$

$$V_{ca} = 1 - 0.01 - \frac{195}{1000x1} - \frac{303.33}{1000x3.13} - \frac{130}{1000x2.85} - \frac{6.67}{1000x2.24} - \frac{925.85}{1000x2.705} - \frac{2.17}{1000x1.08}$$

$$V_{ca} = 0.303\ m^3$$

Where

$V_{ca} = Volume\ of\ coarse\ aggregate$

$V_a = Volume\ of\ air$

$V_w = Volume\ of\ water$

$V_c = Volume\ of\ cement$

$V_G = Volume\ of\ GGBS$

$V_{FA} = Volume\ of\ Fly\ Ash$

$V_F = Volume\ of\ Fine\ Aggregate$

$V_{SP} = Volume\ of\ Super\ Plasticizer$

Weight of coarse aggregate = 0.303x2.78x1000 = 842.6 kg/m^3

Step 8: Calculation Volume of Powder Content:

$$V_P = V_c + V_G + V_{FA} \quad (3)$$

$$V_P = \frac{303.33}{1000x3.13} + \frac{130}{1000x2.852} + \frac{6.67}{1000x2.24} = 0.145\ m^3$$

Volume ratio of water to powder = 0.195/0.148 = 1.34
As per IS code this is to be between 0.85 to 1.10. Increased this value to satisfy workability properties.

Step 9: Self Curing Compound:

Self Curing Compound varied from 0.5% for M2 mix to 2% for M5 mix. For M2 mix
Content of self curing compound = 0.005 x 440 =2.20 kg/m^3

3. MIX PROPORTIONS

Concrete mixes M1 to M5 are considered by varying PEG 400 self curing compound from 0% to 2% in steps of 0.5% and mix proportions are shown in Table 4.

4. WORKABILITY TESTS

Slump flow test is conducted and the results satisfy EFNARC guidelines. V funnel test is conducted and the results does not satisfy EFNARC guidelines. The results are as show in Table 5.

5. COMPRESSIVE STRENGTH OF MIXES

The compressive strength of mixes M1 to M5 for 3,7 and 28 days is determined after curing cubes of M1 mix in water and cubes of M2 to M4 in air at room temperature and the results are shown in Table 6 and also shown in Fig 1. For mixes M2 to M4 the 28 days compressive strength is more than the target mean strength. For all mixes the compressive strength obtained is more than the characteristic compressive strength. The optimum dosage of self curing compound is 0.5%. An increase in 52% of 28 days compressive strength observed for M2 mix compared to M1 mix.

Table 6: 3, 7 and 28 Days Compressive Strength of M25 SCC Mixes with Different % of Self Curing Compound

S.No	Mixes (Self Curing Compound %)	Compressive Strength, f (N/mm^2)		
		3 Days	7 days	28 Days
1	M1 (0.0)	16.47	27.78	**30.36**
2	M2 (0.5)	21.74	23.28	**46.15**
3	M3 (1.0)	16.50	25.91	**35.42**
4	M4 (1.5)	15.46	24.70	**34.83**
5	M5 (2.0)	16.14	23.99	**30.12**

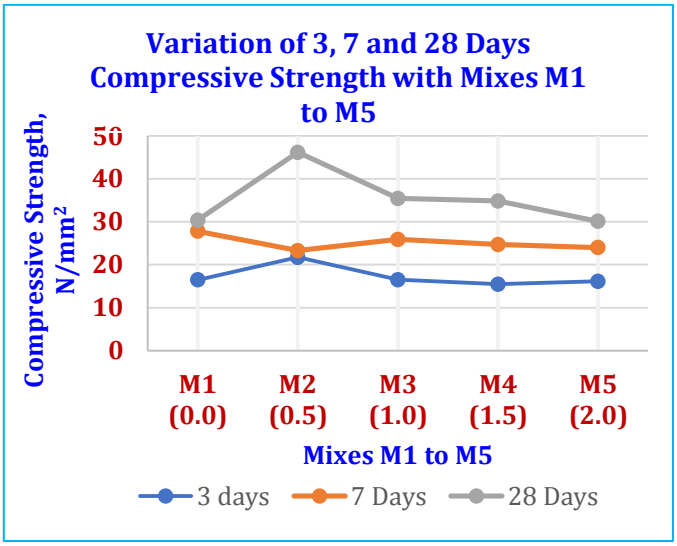

Fig 1. Variation of Compressive Strength with Different mixes M1 to M5 for Ages 3, 7 & 28 days

6. CONCLUSIONS

1. For mixes M2 to M4 compressive strength is more than the target mean strength.
2. For all the mixes the 28 days compressive strength obtained is more than the characteristic compressive strength of concrete.
3. An increase in 52% of 28 days compressive strength observed for M2 mix compared to M1 mix.
4. Mix design by IS 10262-2019 is difficult when fines < 0.125 in fine aggregate is zero when compared to Nan Su Mix Design[1][2].
5. Slump flow slump flow test results are conforming to EFNARC guidelines for SCC. V-funnel test results are not confirming to EFNARC guidelines.

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