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Self-Compacting Concrete with no Flyash and with Low Level of Flyash – A Comparative Study

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ABSTRACT

Self- Compacting Concrete (SCC) was developed to make quality concrete [1] This project focuses on the rheological characteristics of SCC and also the mechanical properties. The mix proportions have been arrived and in this study the quantities of cement are varied and the water- powder ratio is kept as 0.4 throughout the study. Chemical admixtures are used in this study in order to achieve the workability characteristics.

Key words : Self-compacting concrete, Super Plasticizer, Flyash, Workability.

1. INTRODUCTION

To achieve a high flow rate and to avoid obstruction by closely spaced reinforcement, SCC is designed with limits on the nominal maximum size of the aggregate, the amount of aggregate and aggregate grading. [3]

SCC which flows under its own weight and fills into every corner of form work and passes through even restricted spacing of reinforcement, without the need for vibration. The transition zone in SCC is free of micro cracks, in contrast to the normal concrete.[4] In order to get a homogeneous and stable mix in SCC a large amount of powder element plus pozzolanic additions is required so that neither water nor slurry separates out [5-7].

2. EXPERIMENTAL PROGRAM

The investigation was conducted related to the variations in the dosage of chemical admixtures, the funnel speed and the height of rise in the box test [9]. The changes in workability characteristics caused due to this variation of plasticizer dosage were also investigated and given in the Table 3.

In the first investigation the powder content has been kept as 500 kg/m^3 and 21 mixes (CF1- CF21) have been tested in order to achieve the SCC characteristics. Then, the powder content is reduced to 400 kg/m^3 and again its fresh state characteristics are studied by various mixes (S1 – S7). Table 2. gives the details of the mix compositions with different chemical admixture dosage taken for the investigation [12].

Table 1. Typical Range of SCC mix composition

Constituent	Typical range by mass (kg/m^3)	Investigation 1	Investigation 2
Powder	380 – 600	500	400
Water	150 – 210	200	200
Coarse aggregate	750 – 1000	900	900
Fine aggregate	48 – 55 % of total aggregate weight	50 %	50 %

Table 2. Mix composition taken for the investigation

Mix no.	Cement (kg)	Fly ash (%)	Fly Ash (kg)	Sand (kg)	Coarse Aggregate (kg)	Water (kg)	Glenium B233 (%)	Glenium Stream2 (%)
CF1	12.5	0	0	22.5	22.5	5	0	0
CF2	9.375	25	3.125	22.5	22.5	5	0	0
CF5	12.5	0	0	22.5	22.5	5	0.50	0
CF6	9.375	25	3.125	22.5	22.5	5	0.50	0
CF9	12.5	0	0	22.5	22.5	5	0.75	0
CF10	9.375	25	3.125	22.5	22.5	5	0.75	0
CF11	12.5	0	0	22.5	22.5	5	1	0
CF12	9.375	25	3.125	22.5	22.5	5	1	0
CF13	12.5	0	0	22.5	22.5	5	0	0.10
CF14	12.5	0	0	22.5	22.5	5	2	0
CF15	13.75	0	0	24.75	24.75	5.5	2	0
CF16	13.75	0	0	24.75	24.75	5.5	2.50	0.15
CF17	13.75	0	0	24.75	24.75	5.5	2.50	0.30
CF18	13.75	0	0	24.75	24.75	5.5	5	0.30
CF19	10.3125	25	3.4375	24.75	24.75	5.5	5	0.30
S1	11	0	0	24.75	24.75	5.5	4.5	0.3
S2	11	0	0	24.75	24.75	5.5	5	0.3
S3	11	0	0	24.75	24.75	5.5	5.5	0.4
S4	8.25	25	2.75	24.75	24.75	5.5	5.5	0.4
S7	11	0	0	24.75	24.75	5.5	6	0

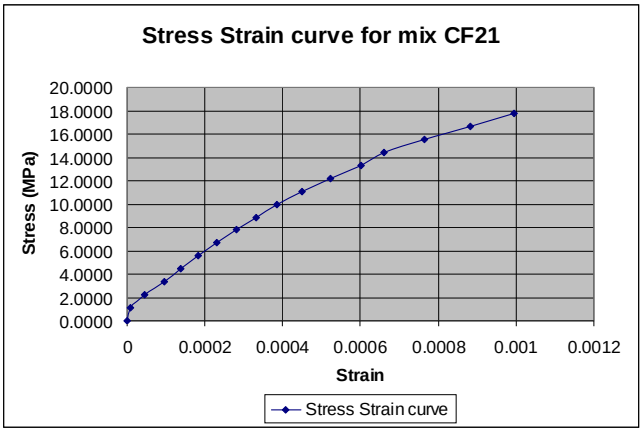

Figure 1. Typical stess strain curve

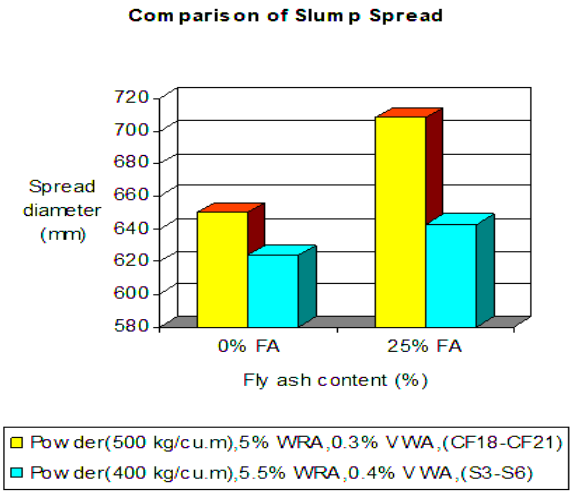

Figure 2. Comparison of slump spread

The SCC mix proportions that were obtained using EFNARC [2] are capable of achieving the SCC characteristics with the replacement of cement by fly ash. More than 25 mixes were carried out to examine the SCC characteristics for developing High Volume Fly ash Self Compacting Concrete (HVFSCC) mixes for Indian conditions [11]. These mixes were proportioned with total powder (cement plus fly ash) contents of 500 kg/m3 and 400 kg/m^3.

Cement replacement level ranging from 0 to 25 % of fly ash and the water/powder ratio as 0.4 for 500 kg/m^3 and 0.5 for 400 kg/m^3 were considered in the study. Coarse and fine aggregate contents are kept as 900 kg/m^3 throughout the investigation and the chemical admixture dosage is varied in order to obtain the SCC characteristics [8-9].

The optimum dosage of the Glenium B233 is found to be 5% for mixes CF18 to CF21 and 5.5% for mixes S3 to S6 when combined with Glenium stream 2 of 0.3% for mixes CF18-CF21 and 0.4% for mixes S3-S6. The test results of the workability investigations are summarized in Table 3. Based on the test results, various classes of SCC as per EFNARC [2] are shown in Table 4. It is observed that mix CF19 satisfies all the classes of SCC. Also, the results clearly explain that the high volume

Table 3. Workability test results

Mix no.	Slump Spread (mm)	T500 (sec)	J ring height (mm)	Time for V funnel (sec)	Filling Height U box (mm)	L box h2/h1
CF1	-	-	-	-	-	-
CF2	-	-	-	-	-	-
CF5	250	-	-	-	-	-
CF6	250	-	-	-	-	-
CF9	300	-	-	-	-	-
CF10	320	-	-	-	-	-
CF11	420	-	-	-	-	-
CF12	450	-	-	-	-	-
CF13	-	-	-	-	-	-
CF14	580	5.63	240	-	-	-
CF15	600	5.22	230	-	-	-
CF16	560	4.65	215	22.65	230	0.31
CF17	575	4.18	196	20.12	238	0.35
CF18	650	4.05	110	11	320	0.5
CF19	708	2.25	97	7	326	0.82
S1	575	5.8	185	24	285	0.5
S2	615	5.2	158	22.5	294	0.6
S3	624	4.8	135	18	302	0.66
S4	643	4.5	94	11	304	0.68
S7	-	-	-	-	-	-

Table 4. Various classes for the SCC mixes

Mix No.	Slump flow class	Viscosity class	Passing ability class
CF14	SF1		
CF15	SF1		
CF16	SF1	VS2/VF2	
CF17	SF1	VS2/VF2	
CF18	SF1	VS2/VF2	
CF19	SF2	VS2/VF2	PA2
S1	SF1	VS2/VF2	
S2	SF1	VS2/VF2	
S3	SF1	VS2/VF2	
S4	SF1	VS2/VF2	

The hardened concrete results are summarized in Table 5. It is observed that the replacement of cement with fly ash as carried out has decreased the strength parameters at 28 days [10]. The average 28 days compressive strength is varied in the range of 15 to 30 MPa.

From the above discussion, it was found that it is difficult to achieve the self-compacting properties without the fly ash content and chemical admixtures. Table 6 gives the details of the Mix proportions for the required strength.

Table 5. Hardened concrete test results

Mix. No	Compressive strength (MPa)	Split tensile strength (MPa)	Flexural strength (MPa)	Young's modulus (MPa)
CF14	35.3	4.1	8.83	29169
CF15	36	4.5	8.3	32315
CF16	35.8	3.3	7.02	30249
CF17	36.6	3.9	6.8	31335
CF18	39.7	4.3	5.2	33439
CF19	27.9	3.5	5.16	26466
S1	36.5	3.8	4.1	31674
S2	37.2	3.5	3.8	35065
S3	38.4	3.7	4.2	32360
S4	26.5	3.4	4.6	26424

Table 6. Mix proportions for required strength

Mix Ratio	W/P ratio	WRA (%)	VMA (%)	Replacement of cement by fly ash (%)	Proposed Compressive Strength (MPa)	Obtained compressive strength (MPa)
1 : 1.8 : 1.8	0.4	5	0.3	25	30	27.9
1 : 1.8 : 1.8	0.4	5	0.3	50	25	25
1 : 1.8 : 1.8	0.4	5	0.3	75	20	20
1 : 2.25 : 2.25	0.5	5.5	0.4	50	20	21

3. CONCLUSION

Following are the conclusions we could arrive from this project.

To achieve the self-compacting properties the mix should contain more fly ash, that is up to 25 replacement of cement by fly ash and the WRA should be used along with VMA.

Cement can be replaced by fly ash up to 25% in order to obtain the SCC characteristics with 28 days compressive strength of 20 MPa. It is also possible to obtain the SCC characteristics by reducing the powder content as low as 400 kg/m^3 with a little increase in VMA dosage (0.3% to 0.4% S3 to S4 mixes) or no increase in VMA dosage (0.3% only S1 to S2 mixes) The visual assessment of various mixes showed that VMA is necessary for achieving SCC characteristics without segregation for both the powder contents 400kg/m2(CF 16 to CF 19)as well as 500kg/m3(S1 to S6).

Here we get remarkable results when SCC is made with a fly ash replacement of 25 percent and a fine aggregate half of the total aggregate. The water- powder ratio was 0.4.

SCC mix requires high powder content (500 kg/m^3), lesser quantity of coarse aggregate (900 kg/m^3), high range SP (5 to 5.5% of cementitious material) and VMA (0.3% to 0.4% of cementitious material) to give stability and fluidity to the concrete mix.

It is possible to achieve strengths varying from 15 – 30 MPa when the cement is replaced by high volume of fly ash. The optimum dosage of the Glenium B233 is found to be 5% for mixes CF18-CF21 and 5.5% for mixes S3-S6 when combined with Glenium stream 2 of 0.3% for mixes CF18-CF21 and 0.4% for mixes S3-S6.

REFERENCES

1. H. Okamura, and M. Ouchi M, **Self – Compacting Concrete**, Journal of Advanced Concrete Technology Vol.1, , pp 5-15, 2003.
2. EFNARC, **The European guidelines for Self-Compacting Concrete specification**, Production and Use, May 2005.
3. A.R. Santhakumar, **Concrete Technology**, Oxford University Press, First Edition, pp. 687- 693, 2007.
4. Praveen kumar and S.K. Kaushik, **Transition zone in self compacting concrete**, Indian Concrete Journal, pp 60-65, June 2004.
5. V. Kumar, B.N Roy, and A.S.R. Sai, **Effect of Super Plasticizer on concrete**, Indian Concrete Journal, pp. 31-33, Jan 1989.
6. P.L. Domone, **Self-compacting concrete: An analysis of 11 years of case studies**, Cement & concrete composites , Vol.28, pp. 197-208, 2006.
7. Burak Felegoglu, Selcuk Turkel, and Bulent Baradam, **Effect of water/cement ratio on the fresh and hardened properties of self-compacting concrete**, Building and Environment
8. G. De schutter, **Guidelines for testing fresh self-compacting concrete, European research project**, www.civeng.ucl.ac.u.k. , Sep 2005.
9. S.Aravindan et al **Characteristic Study of Concrete by Replacing Glass Cullet and Ceramic Tiles over Conventional Aggregates**, INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH, VOLUME 8, ISSUE 10, OCTOBER 2019, Page no – 1802 – 1805.
10. D.S.Vijayan, A. Leema Rose, P.Dinesh Kumar, V.Gokulnath, D Parthiban, "**Sustainable Efficiency of Hypo Sludge in Concrete**", International Journal of Emerging Trends in Engineering Research, Volume 8. No. 9, September 2020, https://doi.org/10.30534/ijeter/2020/94892020
11. D. S. Vijayan, et al., **An experimental study on mechanical and durable properties of self-curing concrete by adding admixture**, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.05.071
12. D. Parthiban et al., **Performance evaluation of Fly ash based GPC with partial replacement of RHA as a cementitious material**, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.05.244