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A STUDY ON THE FRESH PROPERTIES OF SCC WITH FLY ASH

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Abstract- This paper presents the details on the experimental investigation carried out to get the desired fresh properties of the SCC. Tests were performed on various mixtures to obtain the required SCC. In the present research work we have replaced 15% of cement with class F fly ash. By varying the quantity of water and sand the mortar mix was prepared. Later varying percentage of coarse aggregate was added to the mortar to obtain the desired SCC.

***Index Terms*- SCC, paste, fly ash, chemical admixture, fresh properties.**

I. INTRODUCTION

Self-Compacting Concrete (SCC) is characterized as a high performance concrete which has the properties of passing ability, filling ability and resistance to segregation. The use of SCC aids at providing a better and reliable structure with improved durability and high strength. Its honey like flowing property helps in completely filling the formwork without the need of any mechanical vibrations.

SCC constitute of paste and coarse aggregate. Paste consists of cement, fly ash, water and chemical admixture. Various tests were performed on the paste and after we obtained the satisfactorily results then coarse aggregate is added to the paste to obtain SCC. As mentioned above in this research work 15% of cement was replaced with class F fly ash. So here the amount of cement and fly ash is fixed thereby we added varying amount of sand and water and the mix that satisfied all the tests was taken as the final mix. Later coarse aggregate was added as per European guidelines to the paste to obtain SCC.

II. EXPERIMENTAL STUDY

A. Material

In the present investigation, ordinary Portland cement of grade 43 conforming to the requirements of IS: 8112- 1989 was used and the chemical properties of cement and fly ash used in the SCC mixture are given in the table I. The fly ash used was obtained from Century Pulp and paper mill, Lalkuan (Uttarakhand). This fly ash falls in the category of class F fly ash. The fly ash had a relatively low specific gravity and fineness modulus of 1.975 and 1.195 respectively.

Locally available Gola river sand (Haldwani, Uttarakhand) passing through 4.75 mm IS sieve. Its specific gravity is 2.60 and fineness modulus is 2.42. The loose and compacted bulk density values of sand are 1670 and 1688 kg/m3 respectively. In the present work locally available coarse aggregate having the maximum size of 12.5 mm was used. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregates were tested as per IS: 383-1970. The fineness modulus came out to be 6.71332.

Commercially available Conplast SP430-SRV obtained from Fosroc chemicals (I) ltd. was used as a chemical admixture, conforming to IS: 9103- 1999.

B. Mix Proportioning

In the process of preparing SCC the initial step includes the preparation of the mortar. The mortar should be sufficiently flow able in order to be efficient to make the coarse aggregate flow along with itself.

First the volume of the paste (powder+water) is chosen. In this study as we have replaced 15% of OPC with class F fly ash so it is clear that the quantity of cement and fly ash was fixed. We varied the quantity of sand and water and carried out test on the mortar. The water cement ratio ranged from 1.25 to 1.29. The dosage of chemical admixture was 2L/100 kg of powder.

Thereafter, varying percentage of coarse aggregate was added to the mortar and the trail mix that passed all the tests was taken as the final SCC mix.

C. Mixing

The chemical admixture chosen for this investigation mainly enhances the workability of the concrete. For the purpose of mixing all the material was weighed and were mixed together. Then one-third of the water was separately taken out of the measured water and the required chemical admixture to be added to the mix was added to that water. Then two-third of the remaining water was added to the mixture and it was thoroughly mixed.

Then th3 mixture of chemical admixture and water is added to the mortar mixture and the minimum time of mixing is 2 minutes. Once the mortar starts flowing the test is to be performed immediately.

D. Experimental Procedure

1. Mortar:

In order to determine the amount of paste and sand test on mortar were conducted. There are two tests namely: flow cone test and V-funnel test as shown in fig. 1 and 2 respectively.

The flow cone test comprises of a cone of height of 60mm, and upper and lower diameter of 70 mm and 100 mm. The cone is moistened and filled to the top and is lifted vertically upwards. The average of the diameters should lie in the range of 240mm- 260mm.

The V-funnel test consist of a V shaped funnel. The funnel is filled up to the top while the bottom of the funnel is blocked so that no mortar flows out. When the funnel is completely filled then the mortar is made to pass the funnel. The funnel should be completely emptied in 7-11 seconds.

2. SCC:

As per the EFNARC guidelines, the fresh properties of SCC were verified by conducting the following tests: Slump flow test, T_{50} slump flow test, J-ring, V-funnel, L-box test and orimet test. Some tests are shown in fig 3, 4and 5.

III. RESULTS AND DISCUSSION

The results of the test conducted on mortar and SCC are presented in table II and III respectively. The amount of powder and sand used to prepare the mortar mix is briefly mentioned in the table. Out of all the mixtures Out of them, **MTM4** accomplished the stipulated requirements. The final percentage of paste and sand was obtained 60% and 40% respectively.

For the fresh properties of SCC the results obtained on adding varying percentage of coarse aggregate conforming the European guidelines is cited in the table. Five number of SCC trial mix were prepared and all above mentioned tests were performed on it. Trial mix SCC1, SCC2 and SCC3 were rejected as their slump flow test value did not lie in the stipulated range i.e. 650- 800 mm. SCC4 was also rejected as it did not comply with the criteria of slump flow T_{50} test. Trial mix **SCC5** satisfied all the stipulated criteria of SCC without any segregation. Hence, it was declared as SCC for the investigation of the present work. Constituent properties of the selected SCC have been highlighted in table.

IV. CONCLUDING REMARKS

This paper describes the results of an experimental study carried out to study the fresh properties of mortar and SCC prepared with 15% replacement of cement with class f fly ash.

With the increase in the powder content the slump flow of the SCC considerably increased. The results were carefully analyzed with the help of the earlier research with the similar materials. It is essential for the mortar to posses good flow ability as then only the SCC obtained will fulfill the mentioned parameters (passing ability, flow ability and resistance to segregation).

The w/p ratio was finalized to be 1.28. The final SCC mix i.e. SCC5 was made of 60% mortar and 40% coarse aggregate. The slump flow and V funnel test justifies the filling ability of the SCC. The J ring and L box indicated the passing ability. Thus an overall assessment of the properties of mortar and the effect of powder on SCC was observed and studied.

Table I Chemical composition of Portland cement and Fly ash

Constituents	Portland cement (% by weight)	Fly ash (% by weight: recommended)	Fly ash (% by weight: used)
CaO	64.01	0.37-27.68	5.10
SiO_2	20.13	27.88-59.40	59.20
Al_2O_3	5.78	5.23-33.99	22.10
Fe_2O_3	2.35	1.21-29.63	3.10
MgO	1.19	0.42-8.79	0.50
SO_3	3.53	0.04-4.71	0.20
Na_2O	0.11	0.20-6.90	0.20
K_2O	0.77	0.64-6.68	Traces
TiO_2	0.37	0.24-1.73	0.70

Table II Mortar test results

Sample No.	Cement (%)	Fly Ash (%)	Sand (%)	w/c	Superplasticiser (lit/100 kg of powder) (%)	V-funnel (sec)	Slump Flow (mm)
Limiting Value	-	-	-	-	-	7-11	240-260
MTM1	45	15	40	1.25	2	14	200
MTM2	45	15	40	1.26	2	13	220
MTM3	45	15	40	1.27	2	12	230
MTM4	**45**	**15**	**40**	**1.28**	**2**	**9.5**	**245**
MTM5	45	15	40	1.29	2	11	265

MTM: Mortar Trial Mix
MTM4 is used in the present study

Table III Properties of Fresh SCC with fly ash

Mix	Slump Flow(mm)	T_{50} (sec)	V-funnel (t_f sec)	V-funnel ($t_{5\,min}$) (sec)	J-Ring height difference (mm)	L-Box (H_2/H_1) ratio	Orimet (sec)	Result
Limiting values as per EFNARC(2005)	650-800	0-5	6-12	6-12	0-10	0.8-1	0-5	
SCC1	560	-	-	-	-	-	-	Failed
SCC2	630	-	-	-	-	-	-	Failed
SCC3	642	-	-	-	-	-	-	Failed
SCC4	675	7	10	8.5	-	-	3	Failed
SCC5	**710**	**3.0**	**8**	**10**	**2**	**0.95**	**3.5**	**Passed**

Fig 1: Flow cone apparatus

Fig 2: V- funnel test apparatus

Fig 3: Slump Flow test apparatus

Fig 4: L-box apparatus

Fig 5: J- ring test

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