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A Study on Rheological Behavior of Self Compacted Concrete with Coarse Aggregate of Size Varying from 6 mm and Less than 6mm

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Abstract: ***Self Compacting Concrete (SCC) is a self- settling concrete without any vibration. Its important property is flowing on its own weight, requiring no labor for its compaction. Usually the aggregate size used in SCC varies from 10mm to 12.5mm, to accomplish for its flow on itself. The maximum percentage of coarse aggregate used in the SCC is about 50 to 55 percent, so that the remaining amount is mortar matrix, which is responsible for flow property of SCC. Now the problem in SCC is to obtain the desired target strength by using the available concrete mix design procedure. It is proved that in Delhi metro railway project that SCC can be effectively used, better than ordinary, high strength and high performance concrete. In this article we are using coarse aggregate, of size 6/5 mm and make an attempt to check its rheological property (Flow property). The method is compared with standard results and its use in Industry is justified.***

Keywords: Rheological behavior of SCC, Flow property of SCC, Effect of aggregate size on Flow property of SCC.

1. Introduction

Self Compacting Concrete, is a new concrete material invented in Japan during 1980's. The advantage of this concrete is that, save in labor, using mineral and chemical admixture to obtain required flow and strength. In this method the admixtures are used so effectively and tailored that the final product which we are obtained should be economical and feasible to the construction Industry. Usually the materials used in self compacting concrete are (i) Cement (ii) Coarse aggregate (iii) Fine aggregate (iv)Water (v) Mineral admixture (vi) Chemical admixture. Cement used here is OPC grade 53, coarse aggregate of 5/6 mm and below. Here an attempt is made to obtain the same flow as obtained by aggregate of size of 10 to 12.5mm. Here cement content used is also less than what is required for aggregate of size 5/6 mm. A comparative study is proposed to obtain flow parameters with standard results. The mechanism and the activity of super plasticizer and Viscosity Modifying Admixture (VMA) is also tested.This method is developed to use the aggregate of size less than 5/6mm and test its rheological behavior of SCC. The SCC is also contains the mineral admixture as silica fume. Its behavior with the cement and aggregates of size 5/6 mm is tested for flow and its final results are compared with standard results. The method is simple and can be applied to all different grades. Here the target strength is fixed as M40 and the cement is replaced by silica fume by 0, 5, 10 and 20 percent.

2. Methodology

Physical Properties of the M40 grade concrete ingredients:

1) Specific Gravity of cement = 3.1
2) Standard consistency of cement = 27%
3) Initial setting time of cement = 45 minutes
4) Final Setting time cement =100 minutes
5) Fineness modulus of cement = 96.4%
6) Specific gravity of silica fume = 2.2
7) Specific gravity of the fine aggregate=2.6
8) Specific gravity of super plasticizer.=1.1

Here using IS -10262 procedure for concrete mix design and IS-456-2000 codes are used to prepare SCC mix of M40. The different percentages of silica fumes are used to replace cement and its rheological behavior is tested by using inverted Slump cone, V funnel Test and L-box test are performed and the results are tabulated.

Table 1: Mix Design for SCC

Percentage of Silica Fume Added	Cement Kg/Cum	Silica Fume Kg/Cum	Fine Aggregate Kg/Cum	Coarse aggregate Kg/Cum	Water Kg/Cum	Super Plasticizer Percentage	VMA Percentage
0	398	0.200	825.25	1006.5	179	3	2
5	415.91	21.84	825.25	1006.5	179	3	2
10	394.02	43.67	825.25	1006.5	179	3	2
20	350.24	87.56	825.25	1006.5	179	3	2

Table 2: Slump Flow

Percentage of Silica Fume Added	Range	Result (Experiment)	Unit	Remarks
0	550-850	630	mm	Acceptable
5	550-850	600	mm	Acceptable
10	550-850	635	mm	Acceptable
20	550-850	660	mm	Acceptable

Table 3: V-Funnel Test

Percentage of Silica Fume Added	Range	Result (Experiment)	Unit	Remarks
0	6-12	11	sec	Acceptable
5	6-12	10	sec	Acceptable
10	6-12	8	sec	Acceptable
20	6-12	9.5	sec	Acceptable

Table 4: L-Box Test

Percentage of Silica Fume Added	Range	Result (Experiment)	Unit	Remarks
0	0.7-1.0	0.9	Ratio	Acceptable
5	0.7-1.0	0.94	Ratio	Acceptable
10	0.7-1.0	0.99	Ratio	Acceptable
20	0.7-1.0	0.91	Ratio	Acceptable

3. Discussion and Conclusion

From Table No 1, it clearly indicates that only silica fume content and cement content is varied, the remaining parameter are kept constant with water cement ratio as 0.4 in the mix design. Table 2 indicates slump flow decreases with increase of percentage of silica fume up to 5 percent and then it further increases with increase of silica fume. It clearly indicates the behavior of concrete that at less percentage of silica fume with crushed aggregate of 5/6mm requires more water to make surface coating of cement paste. Hence it gives less slump. But it requires less water as the silica fume percentage increases it makes cement mortar matrix more cohesive and more fluidity as the surface tension between the particle decreases with increase in silica fume. The water with super plasticizer and Viscosity modifying admixture further helps in reducing the action of intra molecular adhesion and cohesion between the cement concrete mass matrixes.

From Table 3 V-Funnel Test it indicates the variation in time of flow with its self-weight. In the beginning it takes more time because it contains less flow as indicated by table 2. From 10 and 20 percent of silica fume content the flow time is less indicating that workability is improved as we discussed above. The crushed aggregates with the additives perform better than the coarse aggregate of size 10mm and 12.5mm.

From Table 4 L-Box Test also indicates the same rheological behavior as we discussed above. Simply by using some aggregate, cement and admixture with nominal mix we cannot obtain the rheological behavior which is required for concrete placing and obtain the required finish. It requires proper standard method to obtain the desired flow and strength. Here we are keeping the water cement ratio as constant and also we are just test the behavior of silica fume and cement content variation to obtain the required result. As we observed that the results what we obtained are within the limits of standard test results. Still the chemical activities of the silica fume with the other additives are not defined. We are considered it as a cement matrix influence on the other additives and ingredients of concrete.

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