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PROCEDURE FOR MIX DESIGN OF SELF COMPACTED CONCRETE.

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Keywords

Self –Compacting concrete, Fly Ash, Mix Design, Fresh Properties, Hardened Properties, Compersive Strength.

ABSTACT

Self-compacting concrete is a fluid mixture suitable for placing in structures with congested reinforcement without vibration. Self-compacting concrete development must ensure a good balance between deformability and stability. Also, compactibility is affected by the characteristics of materials and the mix proportions; it becomes necessary to evolve a procedure for mix design of SCC. The paper presents an experimental procedure for the design of selfcompacting concrete mixes. The test results for acceptance characteristics of self-compacting concrete such as slump flow; J-ring, V-funnel and L-Box are presented. Further, compressive strength at the ages of 7, 28, and 90 days was also determined and results are included here.

1. INTRODUCTION

Self-Compacting Concrete (SCC), which flows under its own weight and does not require any external vibration for compaction, has revolutionized concrete placement. SCC, was first introduced in the late 1980's by Japanese researchers [1], is highly workable concrete that can flow under its own weight through restricted sections without segregation and bleeding. Such concrete should have a relatively low yield value to ensure high flow ability, a moderate viscosity to resist segregation and bleeding, and must maintain its homogeneity during transportation, placing and curing to ensure adequate structural performance and long term durability. The successful development of SCC must ensure a good balance between deformability and stability. Researchers have set some guidelines for mixture proportioning of SCC, which include i) reducing the volume ratio of aggregate to cementitious material [1-2]; (ii) increasing the paste volume and water-cement ratio (w/c); (iii) carefully controlling the maximum coarse aggregate particle size and total volume; and (iv) using various viscosity enhancing admixtures (VEA) [1].

For SCC, it is generally necessary to use superplasticizers in order to obtain high mobility. Adding a large volume of powdered material or viscosity modifying admixture can eliminate segregation. The powdered materials that can be added are fly ash, silica fume, lime stone powder, glass filler and quartzite filler.

Since, self-compactibility is largely affected by the characteristics of materials and the mix proportions, it becomes necessary to evolve a procedure for mix design of SCC. Okamura and Ozawa have proposed a mix proportioning system for SCC [3]. In this system, the coarse aggregate and fine aggregate contents are fixed and self-compactibility is to be achieved by adjusting the water /powder ratio and super plasticizer dosage. The coarse aggregate content in concrete is generally fixed at 50 percent of the total solid volume, the fine aggregate content is fixed at 40 percent of the mortar volume and the water /powder ratio is assumed to be 0.9-1.0 by volume depending on the properties of the powder and the super plasticizer dosage. The required water /powder ratio is determined by conducting a number of trials. One of the limitations of SCC is that there is no established mix design procedure yet.

This Review paper describes a procedure specifically developed to achieve self-compacting concrete. In addition, the test results for acceptance characteristics for self-compacting concrete such as slump flow, J-ring, V-funnel and L-Box are presented. Further, the strength characteristics in terms of compressive strength for 7-days, 28-days and 90-days are also presented.

1.1. Material Used:

Cement

Ordinary Portland cement (Grade 43) was used. Its physical properties are as given in Table 1.

Fly Ash

Class F Fly ash obtained from "Panipat Thermal Power Station, Haryana, India. The physical properties of fly ash are given in the Table 2.

Table 1. Physical Properties of cement.

Physical property	Results obtained	IS: 8112-1989 [4] specifications
Fineness (retained on 90-µm sieve)	8.0	10mm
Normal Consistency	28%	_
Vicat initial setting time (minutes)	75	30 minm
Vicat final setting time (minutes)	215	600 maxm
Compressive strength 3-days (MPa)	23	22.0 minm
Compressive strength 7-days (MPa	36	33.0 min
Specific gravity	3.15	_

Table 2. Physical Properties of Fly Ash

Sr. No.	Physical Properties	Test Results
1.	Colour	Grey (Blackish)
2.	Specific Gravity	2.13
3.	Lime Reactivity -average compressive strength after 7 days of mixture 'A	2.07Mpa

Admixture

A polycarboxylic ether based superplasticizer complying with ASTM C-494 type F, was used.

Aggregates

Locally available natural sand with 4.75 mm maximum size was used as fine aggregate, having specific gravity, fineness modulus and unit weight as given in Table 4 and crushed stone with 16mm maximum size having specific gravity, fineness modulus and unit weight as given in Table 4 was used as coarse aggregate. Both fine aggregate and coarse aggregate conformed to Indian Standard Specifications IS: 383-1970 [6].

2. RESULT AND DISCUSSION

2.1. Road assets assessment:

The trials were started at 50 percent volume of total concrete as content of coarse aggregates and 40 percent by volume of mortar in concrete as contents of fine aggregates and variation in w/p ratio and super plasticizer was carried out to achieve SCC mixes. In case of further trials, the coarse aggregate content and fine aggregate content were varied with further variation in water/cement ratio. Similarly, different trials were carried out until mix characterizing all the properties of SCC was obtained. Mixes TR1 to TR9 were initial trials to obtain an SCC mix. TR1, TR2, TR3 were trial mixes with cement content of 499 kg/m3 and fly ash content as 111 kg/m3 .The coarse aggregate and fine aggregate contents were kept as 759 kg/m3 and 743 kg/m3, which amounted to 50 % of total concrete and 40% by volume of mortar in concrete, respectively and w/p ratio of 0.90. The super plasticizer content was taken as 0, 0.76 and 3.80 respectively. None of the SCC characteristics was found in the mixes. Thus, the contents of cement, fly ash, coarse aggregates and fine aggregate was varied to 520 kg/m3, 146.0 kg/m3, 684 kg/m3 and 775 kg/m3 respectively, for mixes TR4, TR5, TR6, TR7, TR8 and TR9. In addition, the super plasticizer content was kept constant at 1.14% of powder content. The quantity of water was changed for all mixes from 243 to 273 kg /m3 from TR4 to The trials were started at 50 percent volume of total concrete as content of coarse aggregates and 40 percent by volume of mortar in concrete as contents of fine aggregates and variation in w/p ratio and super plasticizer was carried out to achieve SCC mixes. In case of further trials, the coarse aggregate content and fine aggregate content were varied with further variation in water/cement ratio. Similarly, different trials were carried out until mix characterizing all the properties of SCC was obtained. Mixes TR1 to TR9 were initial trials to obtain an SCC mix. TR1, TR2, TR3 were trial mixes with cement content of 499 kg/m3 and fly ash content as 111 kg/m3 .The coarse aggregate and fine aggregate contents were kept as 759 kg/m3 and 743 kg/m3, which amounted to 50 % of total concrete and 40% by volume of mortar in concrete, respectively and w/p ratio of 0.90. The super plasticizer content was taken as 0, 0.76 and 3.80 respectively. None of the SCC characteristics was found in the mixes. Thus, the contents of cement, fly ash, coarse aggregates and fine aggregate was varied to 520 kg/m3, 146.0 kg/m3, 684 kg/m3 and 775 kg/m3 respectively, for mixes TR4, TR5, TR6, TR7, TR8 and TR9. In addition, the super plasticizer content was kept constant at 1.14% of powder content. The quantity of water was changed for all mixes from 243 to 273 kg /m3 from TR4 to

3. CONCLUSION

- At the water/powder ratio of 1.180 to 1.215, slump flow test, V-funnel test and L-box test results were found to be satisfactory, i.e. passing ability, filling ability and segregation resistance are well within the limits.
- SCC could be developed without using VMA as was done in this study
- The SCC1 to SCC5 mixes can be easily used as medium strength SCC mixes, which are useful for most of the constructions; the proportions for SCC3 mix satisfying all the properties of Self-Compacting Concrete can be easily used for the development of medium strength self-compacting and for further study.
- By using the OPC 43 grade, normal strength of 2.7 MPa to 2.9 MPa at 7-days was obtained, keeping the cement content around 350 kg/m3 to 414 kg/m3. As SCC technology is now being

adopted in many countries throughout the world, in absence of suitable standardized test methods it is necessary to examine the existing test methods and identify or, when necessary to develop test methods suitable for acceptance as International Standards. Such test methods have to be capable of a rapid and reliable assessment of key properties of fresh SCC on a construction site. At the same time, testing equipment should be reliable, easily portable and inexpensive. A single operator should carry out the test procedure and the test results have to be interpreted with a minimum of training. In addition, the results have to be defined and specify different SCC mixes. One primary application of these test methods would be in verification of compliance on sites and in concrete production plants, if self-compacting concrete is to be manufactured in large quantities.

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