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Study of Mix Design of Self Compacting Concrete

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Abstract - ***Self – compacting concrete (SCC) is a high – performance concrete that can flow under its own weight to completely fill the form work and self consolidates without any mechanical vibration. Such concrete an accelerate the placement, reduce the labor requirements needed for consolidation, finishing and eliminate environmental pollution. In this paper we will study the mix design of self compacting concrete by doing various experimental procedures.***

Key Words: *S.C.C, High performance concrete.*

1. INTRODUCTION

Self compacting concrete (SCC) represents one of the most significant advances in concrete technology for decades. Inadequate homogeneity of the cast concrete due to poor compaction or segregation may drastically lower the performance of mature concrete in-situ. SCC has been developed to ensure adequate compaction and facilitate placement of concrete in structures with congested reinforcement and in restricted areas. SCC can be described as a high performance material which flows under its own weight without requiring vibrators to achieve consolidation by complete filling of formworks even when access is hindered by narrow gaps between reinforcement bars. SCC can also be used in situations where it is difficult or impossible to use mechanical compaction for fresh concrete, such as underwater concreting, cast in-situ, pile foundations, machine bases and columns or walls with congested reinforcement. The high flow ability of SCC makes it possible to fill the formwork without vibration. The method for achieving self-compactability involves not only high deformability of paste or mortar, but also resistance to segregation between coarse aggregate and mortar. Homogeneity of SCC is its ability to remain unsegregated during transport and placing. High flow ability and high segregation resistance of SCC are obtained by:

1 A larger quantity of fine particles, i.e., a limited coarse aggregate content.

2 A low water/powder ratio, (powder is defined as cement plus the filler such as fly ash, Silica fumes etc.) And

3 The use of super plasticizer Because of the addition of a high quantity of fine particles, the internal material Structure of SCC shows some resemblance with high performance concrete having self compactibility in fresh stage, no initial defects in early stage and protection against external factors after hardening. Due to the Lower content of coarse aggregate, however, there is some concern that:

(1) SCC may have a lower modulus of elasticity, which may affect deformation characteristics of prestressed concrete members and

(2) Creep & shrinkage will be higher, affecting prestress loss and long-term deflection.

Self compacting concrete can be produced using standard cements and additives. It consists mainly of cement, coarse and fine aggregates, and filler, such as fly ash, water, super plasticizer and stabilizer. The composition of SCC is similar to that of normal concrete but to attain self Flow ability, admixtures such as fly ash, glass filler, limestone powder, silica fume, Super-pozzolona, etc; with some super plasticizer is mixed. Fineness and spherical particle shape improves the workability of SCC.

1.1 Mechanical Properties

- Characteristic compressive strength at 28 days shall be 25 – 60 Mpa.
- Early age compressive strength shall be 5 – 20 Mpa at 12 – 15 hours (Equivalent age at 20^0 C)
- "Normal" creep and shrinkage

2. MATERIALS FOR S.C.C

2.1 Aggregates

The coarse aggregate chosen for SCC is typically round in shape, is well graded, and smaller in maximum size than that used for conventional concrete typical conventional concrete could have a maximum aggregate size of 40 mm or more. Typically, the maximum size of coarse aggregate used in SCC ranges from approximately 10 mm to 20 mm.

Generally aggregates occupy 70% to 80% of the volume of concrete and have an natural rock (crushed stone, or

natural gravels) and sands, although synthetic materials such as slag and expanded clay or shale are used to some extent.

2.2 Cement

Normally available portlant cement of 43 grade or 53 grade can be used.

2.3 Fly-Ash

Fly ash (or) pulverized fly ash is a residue from the combustion of pulverized coal collected by mechanical separators, from the fuel gases of thermal plants. The composition varies with type of fuel burnt, load on the boiler and type of separation. The fly ash consists of spherical glassy particles ranging from 1 to 150 micron in diameter and also passes through a 45-micron sieve.

2.4 Super-Plasticizer

Super plasticizer is essential for the creation of SCC. The job of SP is to impart a high degree of flow ability and deformability, however the high dosages generally associate with SCC can lead to a high degree of segregation. Conplast SP 430 is utilized in this project, which is a product of FOSROC Company having a specific gravity of 1.222. Super plasticizer is a chemical compound used to increase the workability without adding more water i.e. spreads the given water in the concrete throughout the concrete mix resulting to form a uniform mix. SP improves better surface expose of aggregates to the cement gel. Super plasticizer acts as a lubricant among the materials.

3. MIX DESIGN

3.1 Design stipulations

For performing various experiments such as Slump-Test, V-funnel Test, L-Box Test and Compressive and tensile Strength Test for self compacting concrete. Lets take a Mix proportion of M-30 Grade.

The ingredients for self-compacting concrete are similar to conventional concrete. It consists of cement, coarse and fine aggregates, water, mineral and chemical admixtures. Similar to conventional concrete, SCC can also be affected by the physical characteristics of materials and mixture proportioning. A rational mix design method for self-compacting concrete using a variety of materials is necessary. The coarse and fine aggregate contents are fixed so that self-compact ability can be achieved easily by adjusting water-powder ratio, super plasticizer dosage. In the mix proportioning of conventional concrete, the water cement ratio is fixed at from the view point of obtaining the required strength. With self compacting concrete, however, the water powder ratio has to be decided by taking into account self compact ability because self compact ability is very sensitive to this ratio. In most case, the required strength does not govern the water cement ratio because the water powder ratio is small enough for obtaining the required strength of ordinary structures unless most of the powder materials in use not reactive.

The characteristics of the powder, super plasticizer and VMA largely affect the mortar property and so the proper water powder ratio and super plasticizer and VMA dosage cannot be fixed without trial mixing at this stage. Therefore, once the mix proportion is decided, self compact ability has to be tested by slump flow, l-box test and v-funnel test.

TABLE-1 Different Trail Proportions of S.C.C

Ingredients	Trail Mix-1	Trial Mix-2	Final Mix
Cement	270	255 Kg/m^3	240 Kg/m^3
Fly Ash	150	140 Kg/m^3	132 Kg/m^3
GGBS	110	102 Kg/m^3	96 Kg/m^3
Micro Silica	2.7	2.5 Kg/m^3	2.5 Kg/m^3
Fine aggregate	790	845 Kg/m^3	915 Kg/m^3
Coarse aggregate	775	715 Kg/m^3	720 Kg/m^3
Water	200	200 Lit/m^3	192 Lit/m^3
SP-430	13	13 Lit/m^3	12 Lit/m^3
VMA	1.8	1.7 Lit/m^3	1.5 Lit/m^3
SP-430 Dosage	2.5%	2.5%	2.5%
VMA Dosage	.40%	.40%	.40%

4. EXPERIMENTAL RESULTS

TABLE-2 Test Results of Fresh S.C.C

Mix	Slump Flow Test		V-Funnel Test		L-Box Test
	mm	T_{50}(sec)	T_0(sec)	T_5(sec)	H_2/H_1
Trial Mix-1	670	5.0	11	13	.80
Trail Mix-2	675	4.5	10	12	.82
Final Mix	680	4.0	9	11	.84

TABLE-3 Test Results of Hardened S.C.C

Mix	Compressive Strength (N/mm^2)		Tensile Strength (N/mm^2)	
	7 Days	28 Days	7 Days	28 Days
Trial Mix-1	30	42	2.51	3.10
Trail Mix-2	30.5	41	2.312	3.26
Final Mix	28	40	2.39	3.62

5. Conclusions

Based on the investigation conducted for the study of behavior of self compacting concrete the

following conclusions are arrived.

1. As no specific mix design procedures for SCC are available mix design can be done with conventional BIS method and suitable adjustments can be done as per the guidelines provided by different agencies.

2. Trail mixes have to be made for maintaining flow ability, self compatibility and obstruction clearance.

3. For Final Mix:- Compressive strength after 28 Days for M-30 Grade comes out to be 40.0 N/mm^2.

4. For Final Mix:- tensile Strength after 28 Days for M-30 Grade comes out to be 3.6 N/mm^2.

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