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Designing Concrete Of New Era:"Self Compacting Concrete"

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ABSTRACT

In India, infrastructure is given prior importance and it is vision to make India fully developed up till 2020.But, it is a challenging job to produce high strength concrete and one of the problems for this is presence of air voids. At present to reduce these voids many compacting machines like vibrators are used in field. But, this leads to high noise pollution and annoyance the person working on site. Thus, to eliminate this problem related to compaction, strength and noise, a new concrete called Self Compacting Concrete [SCC] is used. It reduces the voids as it flows under its own weight. The strength and durability of SCC is much higher compared to conventional concrete. It also helps in achieving high quality of surface finishes and becomes sustainable as it saves the energy. But, the problem with this type of concrete is that there is no specific mix design for it. Thus, the aim of this research is to give proper methodology for the mix design of self compacting concrete and various points to be kept in mind while designing such flowable concrete.

Keywords: Compaction, Durability, Mix design, Strength, Self compacting concrete.

I. INTRODUCTION

The three basic necessities of humans are food, cloth and shelter. In order to provide shelter, the most important thing needed is concrete. Hence; concrete is the second most selling product just after water.Actually, Concrete is most versatile man-made construction material - can be shaped in a variety of forms. It is most important material used for construction and can be manufactured by proper mix design. Also, the life span of a building depends on mix design and method of execution of concrete. But if we talk about today's concrete than it is found to have various limitations like Scarcity of skilled manpower, Inconsistent construction quality, Increased cost of labour and materials, Reduce in durability and life span of structure, Inadequate compaction in densely reinforced concrete, Noise pollution due to vibration, Increasing cost of Repair and maintenances etc. One of the main reasons of getting low strength of Concrete is due to lack of compaction. Basically, compaction of concrete is a process adopted for expelling the entrapped air from concrete. Also, it has been witnessed that if air is not removed fully then concrete looses strength. Presence of 5% of voids reduces the strength by 30% and 10% of voids reduces the strength over 50%.Thus, it is very important to keep in mind to have 100% of compaction of concrete. But in India, it is next to impossible to get 100% compacted concrete due to lack of skilled labours ,malpractices ,lack of communication skill between designers and construction engineers ,etc. Along with this, the noise produced by the vibrators and compacting machine is of very high decibel which may result into hearing losses and annoyance the person working on the site. Thus the only one solution for all such problems is the new kind of High performance concrete, a newer type of concrete that is concrete of new era called "SELF COMPACTING CONCRETE"

The concept of such type of concrete originated for the first time in Japan by Prof. Hajimeokamura (1986).Further; the prototype was first developed in 1988 in Japan by Professor Ozawa (1989) at university of Tokyo. Basically, SCC is defined as concrete that is able to flow and consolidate under its own weight, completely fill to formwork even in the presence of dense reinforcement maintaining homogeneity without compaction. Actually, SCC was deliberately designed to be able to fill every corners of form work and encapsulate all reinforcement with maintain stability only under the influence of gravitational force without segregation or bleeding .Self compacting concrete (SCC) is concrete with the ability to compact itself only by means of its own weight without the requirement of vibration. It flows under the influence of gravity without segregation during which it and completely fills the formwork and spaces between the reinforcement without any need of induced compactions. For concrete to be self-

compacting it should have filling ability, passing ability and. resistance against segregation.

Filling ability- It is the ability of SCC to flow into and fill completely all spaces in the formwork by its own weight. It gives us idea about the fluidity of concrete.

Passing ability-It is the ability of concrete mix to pass through obstacles like narrow sections aggregate particles. It gives us idea about the flow through tight openings such as spaces between steel reinforcing bars without segregation and blocking.

Resistance to segregation- Segregation resistance of self-compacting concrete is its capability to retain homogeneity in the distribution of ingredient in fresh state during both static and moving condition i.e. during mixing, transportation and Placing. It is dependent on viscosity of mix at fresh state. The basic principle for designing self compacting concrete is as shown in fig.1

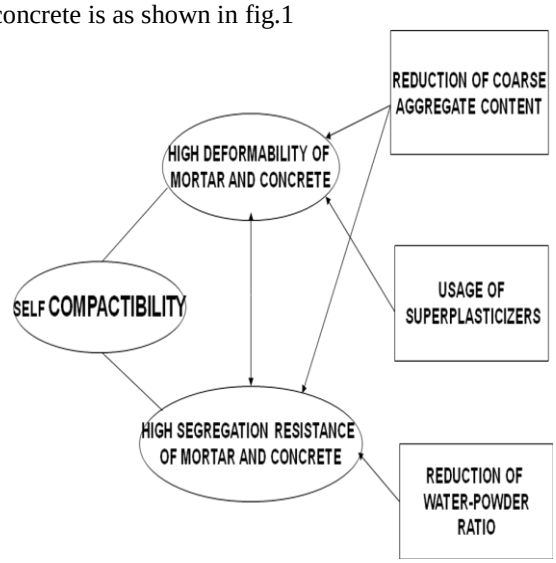

Fig. 1 Principle of self compacting concrete

Hence from above figure is clear that in order to obtain SCC we need to follow the above three steps. Along with that the other important point to be noted is that all material available in market cannot be used for producing SCC. It is found that SCC is very sensitive to the property of the materials used.It is very necessary to have uniformity of the property.

II. Properties of Materials

2.1 CEMENT:

In this research Ultra tech cement of OPC 53 grade which is locally available in market was used having specific surface area 350.00 m²/Kg ,specific gravity 3.12.

2.2 COARSE AGGRAGATE:

Coarse aggregate used was locally available from the nearby RMC Plant having maximum 12.5 mm with specific gravity 2.78 & water absorption 1.76.

2.3 FINE AGGRAGATE:

River sand having maximum size 4.75 mm was used having specific gravity 2.7, fineness modulus 2.413, and water absorption 1.29.

2.4 FLY ASH:

Ukai thermal power plant fly ash with specific gravity 2.2 was used for the project.

2.5 SUPER PLASTICIZER:

Polycarboxylic ether based super plasticizer named GLENIUM 149 of BASF chemicals pvt. ltd was used.The relative density of SP was 1.15+0.01 and PH was 6.83+1.

III. Experimental work

In all five different trial mixes were made and all various fresh properties were checked to ensure that obtained mix is of Self compacting concrete. The trial mixes were designed on the basis of experiences and observations of the previous mix.

Table-1 Different trial mixes

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
CEMENT	450	450	450	450	450
WATER	117	180	213.3	209	194
SAND	925.5	532.3	707	611	842
C.A	1002	974.6	797	688	603
FLY ASH	-	266.2	265	264	135
S.P	4.97	5.38	7.36	3.6	4.4

IV. Results

Table-2 Fresh properties results

Trial no. / Test	1	2	3	4	5	Requirement
Slump cone(mm)	230	720	700	600	760	650-800
T_{50}(sec)	-	3	5	6	4	2-5
J-ring(mm)	-	2	1	1	1	0-10
V-funnel (sec)	-	20	9	10	10	8-12
U-box (mm)	-	10	26	25	23	Up to 30

V. Discussion

Various observations made from each of the trial mix were as follows:

5.1 Trial 1.

It can be clearly seen that the water-cement ratio is very less and hence, the self compacting concrete obtained was very dry. It was not possible even to do slump test for such concrete. Along with this the super plasticizer used was Glenium based and thus, the concrete had hardened very soon. Even there was no binding between the cement and the aggregate. Therefore, from first trial mix, we concluded that the water-cement ratio of the mix should be increased and there should be some mineral admixture which on adding with cement acts as a good binder in the concrete. The coarse and fine aggregate were sufficient enough to obtain SCC.

5.2 Trial 2

In this design mix we tried to remove the problem of binder material by adding fly ash into the concrete. Also the water-cement ratio was increased from 0.26-0.40. Even the content of coarse and fine aggregate was approximately adjusted. But, the problem with such concrete was that the aggregate started getting segregated. Thus, from above trial mix we found that still water-cement ratio is less and the content of cement and course aggregate is comparatively less. The dosage of SP was also found to be les

5.3 Trial 3

In order to overcome the drawback of the above trial mix, the water content of concrete was increased and even the dosage of SP had even increased. In this trial mix, we had changed our super plasticizer from Glenium based to Naphthalene based. Using Naphthalene based SP, self compacting concrete was achieved. But, when we kept the cube for curing then we found that bleeding of concrete was seen which may result in to weak concrete strength. Hence, the third trial mix taught us that it is easy to achieve SCC using Naphthalene based super plasticizer, but it directly affects the mechanical properties of concrete. Even, large amount of Naphthalene based SP is used which directly increase the cost of concrete.

5.4 Trial 4

In the fourth trial we again moved on to Glenium based SP. Here, we optimized the dosage of SP up to 3.6 kg. from 5.38 kg. but the limitation with this mix was that it had resulted into a large amount of segregation of aggregate and sand.In this mix we found out that segregation is very high and one of the reasons for this is that the binder material present in concrete is very large

5.5 Trial 5

Here, there was reduction in the content of binder material in concrete and increase in the finer material of concrete. Even the SP content was increased from 3.6 to 4.6 kg. This concrete achieved had satisfy all the necessities of self compacting concrete and thus, it was our final mix design for 450 kg/m^3 of cement content

VI. Conclusion

From the Experimental research of 5 self compacting concrete mixes, following conclusions can be drawn:

1) Self compacting concrete has wide scope in future and it can be considered as the concrete of new era.
2) From the trial mixes we have understood that the self compacting concrete is very sensitive and is directly affected by the property of content used in concrete. The little variation in physical parameters of the material used can greatly affect the flowing ability of the concrete.
3) Even it is necessary to understand the compatibility between the super plasticizer and cement. The lower dosage of super plasticizer results into bleeding and higher dosage of SP results into segregation and hardening of concrete.

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