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A study on mechanical properties of self compacting concrete (powder type)

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***Abstract*— Self-compacting concrete was first developed in japan 1980's .This concrete can flow through congested reinforcing bars with elimination of compaction. It enhances construction productivity, reduces overall cost and improves work environment. It helps in achieving better surface finish and improves workability. The admixtures such as super plasticizer and fly ash reduce heat of hydration. SCC is obtained by limiting the water/cement ratio incorporating an effective superplasticizer, high quality of fines increasing the sand / aggregate ratio.SCC is a material with good flow ability passing ability and resistance against seggregation.SCC is used in precast concrete construction due to its precast concrete construction due to its strength and filling ability. It improves construction of others engineering structures.**

***Index Terms*—Superplasticizer,SCC**

I. INTRODUCTION

The concrete technology has made tremendous studies in past decade. Concrete is now no longer a material consisting of cement, aggregates, water and admixtures but it is an engineered material with several new constituents. The concrete today can take care of any specific requirements under most of different exposure conditions. The self compacting concrete is a flowable Concrete mixture that is able to consolidate under its own weight. It does not require any external vibration for compaction. The highly fluid nature of SCC makes it suitable for placing in difficult condition and in sections with congested reinforcement SCC does not show segregation and bleeding. Much more is demanded of SCC in its fresh state than of conventional vibrated concrete, and it became clear that the remaining fundamental obstacle to the wider use of SCC in Europe was the absence of suitable test methods to identify and specify its three key fresh properties are passing ability, filling ability and resistance to segregation. Although there were a number of test methods, these had often been developed for specific applications with little or no attempt to ensure that they were more generally applicable, and there was no immediate prospect, anywhere, of a standardized test. This was hindering the increased use of SCC since it was difficult to validate mix designs except by full-scale trials, and confidence in the material was therefore undermined

II. OBJECTIVE OF THE PROJECT

- To study the relation between strength of SCC.
- To increase usage of industrial by-products in manufacture of concrete.
- To develop and enhance properties of SCC.
- To evaluate function for manual summarizing of compressive and flexural strength of SCC.

III. SCOPE OF THE PROJECT

- To improve filling capacity through highly congested reinforcement by using the Self Compacting concrete.
- To reduce the construction time in the project.
- To get good surface finishing.

IV. ADVANTAGES OF SCC

Advantages of SCC over Normal Concrete are as follows:

- Faster construction
- Reduction in site man power
- Better surface finishes
- Easier placing
- Reduced noise levels in work site
- Economical construction
- Improved filling capacity through highly congested

reinforcement

V. Application areas of SCC

The main reason for the employment of self-compacting concrete can be summarized as follows:

1. To shorten construction period.
2. To assure compaction in the structures, especially in confined zones where vibrating compaction is difficult.
3. To eliminate noise due to vibration, at concrete products plans.

SCC may be used in pre-cast applications or for concrete placed on site. It can be manufactured in a site batching plant or in ready mix concrete plant and delivered to site by truck. It can then be placed either by pumping or pouring into horizontal or vertical structures. In designing the mix, the size and the form of structure, the dimension and density of reinforcement and cover should be taken in consideration.

These aspects will all influence the specific requirements for the SCC. Due to the flowing characteristics of SCC it may be difficult to cast to a fall unless contained in a form. SCC has made it possible to cast concrete structures of a quality that was not possible with the existing concrete technology.

VI. CHARACTERISTIC OF SCC

Characteristic of fresh SCC

The main characteristic of SCC are the properties in fresh state. In order to flow, fill through the dense reinforcement the SCC must pose certain properties like flow ability, fill ability, resistance for segregation.

The major properties of SCC are:

- Passing ability (confined flow ability).
- Filling ability (unconfined flow ability).
- Resistance to segregation or stability
- (segregation resistance)

Passing ability

- The ability of SCC to flow through tights openings such as spaces between steel reinforcing bars without segregation or bleeding.
- The flow ability of the mix is tested by the V-funnel test.
- The flow ability of the mix is increased by having a suitable w/p ratio.
- The use of super plasticizers helps to increase the workability of the concrete.

Filling ability

- The ability of SCC to flow into and fill completely all spaces within the formwork, under its own weight.
- This property is achieved by addition of super plasticizers and by optimizing the packing of fine particles by adding fillers.
- This test is done by using slump cone test.

Resistance to segregation

It is the ability of concrete to remain uniform and cohesive throughout the entire construction process.

- There should be minimum segregation of the aggregates from the matrix and little bleeding.
- V-funnel T-5 test is done to check the resistance to segregation.
- Stability is largely dependent on the cohesiveness and viscosity of the concrete mixture.
- A reduction of free water content has been shown to improve stability while decreasing inter-particle friction among solid particles.

Characteristic of hardened SCC

In normal concrete, during vibration, water tends to migrate to the surface of the coarser particles causing porous and weak interfacial zones to develop. In case of well-designed SCC the homogeneity, mobility, cohesiveness helps placing concrete in formwork without compaction. This helps in better interface between coarse aggregate and mortar paste as minimal interfacial zone develops. The microstructure of SCC can be therefore expected to the superior, promoting strength, impermeability, durability and ultimately longer service life of concrete.

- High quality of placed concrete is achieved, regardless the skill of the workers.
- Good bond between concrete and reinforcement is obtained, even in congested reinforcement.
- High quality of concrete surface finish is obtained with no need for subsequent repair.
- With a better final appearance of concrete surface, smooth wall surfaces and flat floor surfaces that need no further finishing are obtained.
- Improved durability of structures is achieved.
- Maintenance costs are reduced.

VII. Materials

A. Cement

53 grade Ordinary Portland cement is used for the study Programme. The properties of this cement have been tested and given below:

Specific gravity of Cement = 3.15
Initial Setting Time = 30 minutes

B. Fine Aggregate

River sand was used in preparing the concrete as it was locally available in sand quarry. The properties of this fine aggregate have been tested and given below:

Specific gravity of fine aggregate = 2.7
Water absorption = 2.5%

C. Coarse Aggregate

Aggregate must be equal to or better than the hardened cement to withstand the designed loads and the effects of weathering. The properties of this coarse aggregate have been tested and given below:

Specific gravity CA = 2.6
Bulk density of coarse aggregate = 1487.6 Kg/m^3
Water absorption = 1.5%

D. Water

Potable water available in laboratory with pH value of 7.0 ± 1 and confirming to the requirement of IS: 456-2000 was used for mixing concrete and curing the specimens as well.

E. Fly Ash

Fly ash can be an expansive replacement for Portland cement in concrete all through using improving strength,

segregation, and case of pumping concrete. The rate of substitution specific is 1 to 1.5 pounds of fly ash to 1 pound of cement. The amount of fine aggregate should be reduced to accommodate fly ash additional volume. Fly ash is a fine powder which is a by product from burning pulverized coal in electric generation powder plants.

F.Superplasticizers

Superplasticizers, also known as high range water reducers, are chemicals used as admixtures where well-dispersed particle suspension is required. These polymers are used as dispersants to avoid applications. Their addition to concrete or mortar allows the reduction of the water to cement ratio, not affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete.

Mix proportion

Class C Fly Ash (MTPS) is used as a mineral admixture @ 30% replacement cement. Super plasticizer (Glenium B233) was used @ 0.5% by weight of powder.

Table1: Mix proportion for various grades of SCC

S.No	Cement	FA	CA	Fly ash (Kg/m)	Water (%)	SP (%)
1	438.382	928.2	1014	187.8	0.4	0.5

VIII. TEST ON FRESH PROPERTIES OF SCC

A. Slump Flow test

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete.

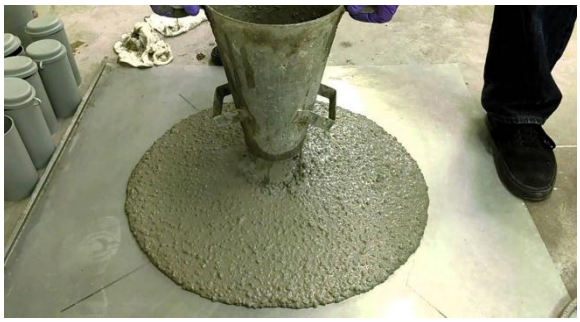

Fig.1. Slump flow test

The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

B.V-Funnel test

The test was developed in Japan and used by Ozawa et al. The equipment consists of a V-shaped funnel, shown in Fig. An alternative type of V-funnel, the O funnel, with a circular section is also used in Japan. The described V-funnel test is used to determine the filling ability of the concrete with a maximum aggregate size of 20mm. The funnel is filled with about 12 liters of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increase significantly.

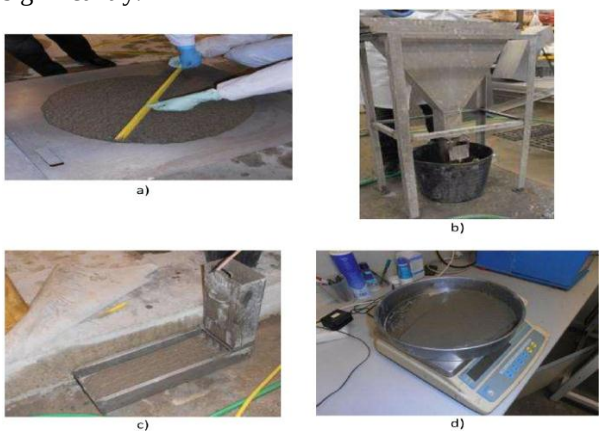

Fig.2. V-funnel test

Tests on Hardened Concrete

S. No	Trail Mix	7 Days Split Tensile Strength (N/mm^2)	28 Days Split Tensile Strength (N/mm^2)
1	SCC 1	2.70	3.95
2	SCC 2	2.85	4.25
3	SCC 3	3.0	4.47
4	SCC 4	2.79	4.30
5	SCC 5	2.88	4.08
6	SCC 6	2.93	4.30
7	SCC 7	3.12	4.50
8	SCC 8	2.90	4.40

A. Compressive Strength

One of the important properties of concrete is its strength in compression. The strength in compression has definite relationship with all other properties of concrete i.e. these properties are improved with the improvement in compression strength. The aim of this experimental test is to determine the maximum load carrying capacity of test specimens. The compression test specimens were tested on a compression testing machine of capacity 2000 kN. The specimen was placed on machine in such a way that its position is at right angles to its own position which it had at the time of casting. Load is applied gradually as the rate of 14 N/mm^2/min or 320 kN/min.

Test setup for Compressive Strength

B. Split Tensile Strength

The Split Tensile test of cylinder is checked after 7, 28 days. The strength is the most important for mechanical property of concrete, shown in table below.

Test setup for Split Tensile Strength

S.No	Trail Mix	7 Days Split Tensile Strength (N/mm^2)	28 Days Split Tensile Strength (N/mm^2)
1	SCC 1	2.70	3.95
2	SCC 2	2.85	4.25
3	SCC 3	3.0	4.47
4	SCC 4	2.79	4.30
5	SCC 5	2.88	4.08
6	SCC 6	2.93	4.30
7	SCC 7	3.12	4.50
8	SCC 8	2.90	4.40

S. No	Trail Mix	7 Days Compressive Strength (N/mm^2)	28 Days Compressive Strength (N/mm^2)
1	SCC 1	27.51	41.41
2.	SCC 2	28.22	44.33
3.	SCC 3	30.45	46.75
4.	SCC 4	27.87	44.56
5.	SCC 5	27.77	41.69
6.	SCC 6	29.02	44.59
7.	SCC 7	30.59	46.98
8.	SCC 8	28.32	44.69

IX. Results and Discussion

- The trail mix 7 shows the higher cube compressive strength, split tensile strength and cylinder compressive strength with 46.98 N/mm^2, 4.50 N/mm^2 and 46.28 N/mm^2 for 28 days respectively.
- The trail mix containing 30% fly ash, 0.5% super plasticizers. It gave good results.

X. Conclusion

- Basic tests for cement, coarse aggregate and fine aggregate were conducted and results were listed.
- The mix design for the self compacting concrete is found out with using V funnel and slump flow test.
- The acquired mix design is used for casting prism and cube with replacement of cement with use of fly ash about 30%.
- Test result for 7 days and 28 days mechanical properties of M40 grade self compacting concrete were shown in graph.

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