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Effect of Size of Aggregate on High Strength Self Compacting Concrete

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Abstract: ***Concrete is a versatile widely used construction material. Researchers are always trying to improve its quality and enhance its performance, ever since concrete has been accepted as a material for construction. Recent changes in construction industry demand improved durability of structures. From a strength based concept to a performance based design, there is a methodological shift in the design of concrete. At present scenario on performance aspect of concrete there is a large emphasis. The development of Self Compacting Concrete (SCC) is one of the idea of such researches. It is considered as "the most revolutionary development in concrete construction". SCC is a new kind of High Performance Concrete (HPC) with excellent deformability and segregation resistance. It can flow through and fill the gaps of reinforcement and corners of moulds without any need for vibration and compaction during the placing process the guiding principle behind self-compaction is that "the sedimentation velocity of a particle is inversely proportional to the viscosity of the floating medium in which the particle exists". The other features of mix proportion of SCC include low water to cementations material ratio, high volume of powder, high paste to aggregate ratio and less amount of coarse aggregate. One of the popularly employed techniques to produce Self Compacting Concrete is to use fine materials like Fly Ash, GGBFS etc: in concrete, besides cement, the idea being to increase powder content or fines in concrete. The present investigation is aimed at developing high strength Self Compacting Concrete of M70 Grade. The parameters of study include grade of concrete and effect of size of aggregate. The existing Nan Su [2001] method of mix design was based on packing factor for a particular grade of concrete, obtained on the basis of experimental investigation. SCC characteristics such as flow ability, passing ability and segregation resistance have been verified using slump flow, L box and V funnel tests.***

Keywords: Self compacting concrete, High -strength concrete, High performance concrete, GGBS, Deformation and Segregation

1. Introduction

The versatility and the application of concrete in the construction industry need not be emphasized. Research on normal and high strength concrete has been on the agenda for more than two decades. As per IS: 456–2000[Code of Practice for Plain and Reinforced Concrete], concretes ranging 25 – 55 MPa are called standard concretes while those above 55 MPa can be termed as high strength concrete. Concretes above 120/150 MPa are called ultrahigh strength concrete. High strength concrete has numerous applications worldwide in tall buildings, bridges with long span and buildings in aggressive environments. Building elements made of high strength concrete are usually densely reinforced. This congestion of reinforcement leads to serious problems while concreting. Densely reinforced concrete problems can be solved by using concrete that can be easily placed and spread in between the congested reinforced concrete elements. A highly homogeneous, well spread and dense concrete can be ensured using such a type of concrete.

2. Scope of Study

Despite its advantages and versatile nature, SCC has not gained much popularity in India, though it has been widely promoted in the Middle East for the last two decades. Awareness of SCC has spread across the world, prompted by concerns with poor consolidation and durability in case of conventionally vibrated normal concrete.

All the researchers have developed SCC taking the CA/FA ratio and also considered the limited content of coarse aggregate and more content of fines. But, there are very limited investigations reported considering the size effect of coarse aggregate content in the development of SCC. Keeping this in view, the present experimental investigation is taken up to study the effect of size of coarse aggregate in the development of M70 grade of Self Compacting Concrete. Powder content is the main aspect of a SCC mix design. In the present work, fly ash is maximized in the SCC mixes as a filler material.

3. Experimental Program

Materials used in this are as follows:

Cement:
Ordinary Portland cement of 53 grade was used for this study.

Coarse aggregates:
Aggregate most of which is retained on 4.75-mm IS Sieve and containing only so much finer material as is permitted for the various types described in this standard. Coarse aggregate may be described as: a) uncrushed gravel or stone which results from natural disintegration of rock, b) crushed gravel or stone when it results from crushing of gravel or hard stone, and c) partially crushed gravel or stone when it is a product of the blending of (a) and (b).

Figure 1: Coarse aggregates

Fine aggregates
Aggregate most of which passes 4.75-mm IS Sieve and contains only so much coarser material. The sand particles should be free from inorganic materials and found to be hard & durables.

Super Plasticizer
High range water reducing admixture called as super plasticizers are used for improving the flow or workability for lower water-cement ratios without sacrifice in the compressive strength. These admixtures when they disperse in cement agglomerates significantly decrease the viscosity of the paste by forming a thin film around the cement particles. In the present work, water-reducing admixture Glenium conforming to IS 9103: 1999 [Specification for admixtures for concrete], ASTM C – 494 [Standard Specification for Chemical Admixtures for Concrete] types F, G and BS 5075 part.3 [British Standards Institution] was used.

Viscosity Modifying Agent
These admixtures enhance the viscosity of water and eliminate the bleeding and segregation phenomena in the fresh concrete as much as possible.VMA is a neutral, biodegradable, liquid chemical additive designed to reduce the bleeding, segregation, shrinkage and cracking that occur in high water/cement ratio concrete mixes. VMA also contribute to stabilization for SCC mixes that are susceptible to segregation at high slump ranges. The Viscosity Modified Agent used in this study was Glenium stream-2 which is a product of BASF construction chemicals.

Water
Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. It gives strength to cement & workability to the concrete. Drinking water is used for casting and curing.

Mix proportions
Production of quality concrete requires proper care taken at every stage of preparation of concrete. Tentative mixes of the materials were studied in the proposed study. for each mix batching and mixing were done. All the specimens were cast using steel moulds& cured in water at the room temperature.

4. Test Results

4.1 Compressive strength

Grade of concrete, maximum size of aggregate and age of curing are the variables of investigation. The details of the compressive strengths of M70 grades are shown in Tables 1.

Table 1: compressive strengths of M70 grade of SCC

Size of aggregates	3 days	7days	28 days
20 mm	32.1	46.32	74.10
12.5 mm	35.72	49.20	77.24
10 mm	38.69	50.24	79.44

From the results it was noted that, as the grade of concrete increased the effective maximum size of the aggregate has deceased. In the above cases, the cement content was 680 kg/m^3 for M70 grades. The three effective sizes for the above three mixes have been arrived and the same was adopted in the further study.

4.2 Graphs

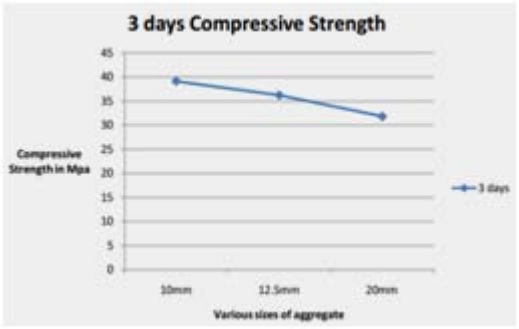

Figure 2: 3days Compressive strength with various sizes of Aggregates

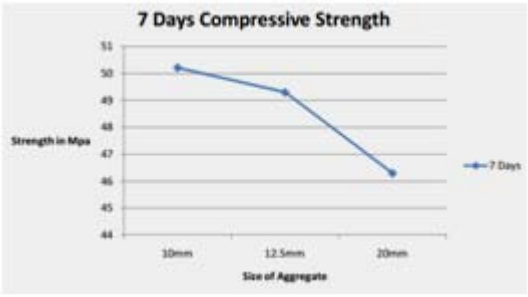

Figure 3: 7days Compressive strength with various sizes of Aggregates

Figure 4: 28days Compressive strength with various sizes of Aggregates

After testing the specimens the results are as follows:

Compressive strength of concrete for 3,7 and 28 daysgraphs are plotted.

5. Conclusions

Based on the systematic and detailed experimental study conducted on SCC mixes with an aim to develop performance mixes, the following are the conclusions arrived.

1) The mixes designed using the lower size of aggregate yielded better fresh properties than higher size of aggregates.
2) As the strength of concrete increases, the effective size of aggregate has decreased. However, additional experimental results are needed in this regard.

6. Significant Contribution of the Project

The present investigation has brought out explicitly the effect of size of aggregate on the compressive strength of self-compacting concrete.

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