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Experimental Investigation on Self Compacting Concrete Addition of Marble Powder and Silica Fume

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Abstract—*The paper entitled with "Experimental Investigation on self compacting concrete addition of marble powder and silica fume" deals with mechanical properties like compressive, split tensile and flexural strength of self compacting concrete. In this experimental work different percentages of marble powder (MP) and silica fume (SF) are added. Experiments are carried out addition of marble powder (20%, 30%, 40%, 50%) and silica fume (5%). Several tests such as slump flow, V-funnel, are carried out to determine optimum parameters for the self-comp actability of mixtures. Test on Compressive strength, Split tensile strength, flexural strength and deformation characteristics of the specimens are studied. The results obtained from these tests are compared with conventional concrete specimens. The load deflection curves are also drawn. The results show that 20% and 30% addition of marble powder and 5% silica fume improves the properties of SCC.*

1. INTRODUCTION

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

Concrete that requires little vibration or compaction has been used in Europe since the early 1970s but self-compacting concrete was not developed until the late 1980's in Japan. In Europe it was probably first used in civil works for transportation networks in Sweden in the mid l990's. The European Countries funded a multi-national, industry lead project SCC 1997- 2000 and since then SCC has found increasing use in all European countries.

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of SCC ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier remolding and faster use of elements and structures.

- SCC has been described as "the most revolutionary development in concrete construction for several decades". Originally developed to offset a growing shortage of skilled labour, it has proved beneficial economically because of a number of factors, including, faster construction
  - Reduction in site manpower
  - Better surface finishes
  - Easier placing
  - Improved durability
  - Greater freedom in design
  - Thinner concrete sections
  - Reduced noise levels, absence of vibration
  - Safer working environment

Originally developed in Japan, SCC technology was made possible by the much earlier development of super plasticisers for concrete. SCC has now been taken up with enthusiasm across Europe, for both site and precast concrete.

Work. Practical application has been accompanied by much research into the physical and mechanical characteristics of SCC and the wide range of knowledge generated has been sifted and combined in this guideline document.

BASIC PRINCIPLE OF SCC: To attain high workability on concrete, it is necessary to have a good spacing between the aggregates, as to minimize the friction between them. A concrete sample with a good spacing between the aggregates is covered by cement paste, we could then compact the aggregates, and squeeze out the excess cement paste surrounding them. What left is a top layer with just the paste itself, and below it a compact state of aggregates, with just enough cement paste to fill in the void space. This cement paste in between the voids is called the 'compact paste'. And the cement paste that wraps around the aggregates is called 'excess paste'. This excess paste allows the aggregate to disperse easily in the matrix which helps the concrete to flow easily and maintains homogeneous dispersion.

2. LITERATURE REVIEW

M. Collepardi (1980) has done some experiments on SCC and summarizes the results on flowing and cohesive super plasticized mixtures studied and placed in the 1970's and 1980's with properties. They are very close to those of Self-Compacting Concretes (SCCs) presently considered to be the most advanced cementations material. In particular, it was suggested that the ingredients of these mixtures (super plasticizer, cement, fly ash, ground limestone, silica fume, etc.) by examining their specific role in determining the main properties of these concretes, such as fluidity, on the one hand, and resistance to segregation, on the other. Some interesting new materials, such as ground fly ash or powder from recycled aggregates, appear to be very promising for manufacturing self compacting concrete in agreement with the requirements needed for sustainable progress.

Okamura and Ozawa (1994, 1995) developed slump flow, funnel flow, test apparatus for fill ability. They recommended that while the w/c ratio of SCC must be decided based on strength considerations, the w/c ratio governs the self compatibility in most cases.

European guide lines (1998) explains all the fresh concrete tests like Slump-flow by Abrams cone, T5Ocmslumpflow, V-funnel, Orimet with its permissible limit.

Okamura, Hajime (1997) they are explain self compacting concrete performance to achieve high strength during its hardened.

A. Foroughi-Asi, S. Dhlmaghani, H. Famili (2006) In this paper, the bond between self compacting concrete and steel reinforcement was investigated. The bonding strengths of reinforcing bars were measured using cubic specimens of self compacting concrete and of normal concrete. The self compacting concrete specimens were cast without applying compaction, whereas the specimens of normal concrete were cast by conventional practice with substantial compaction and vibration. The results showed that self compacting concrete specimens generated higher bond to reinforcing bars than normal concrete specimens and the correlation between bond strength and compressive strength of normal concrete is more consistent.

Md. Safiuddin, J.S. West, and K.A. Soudki (2008) told the self compacting concrete is emerging as a new generation of high-performance concrete with the aim of building durable concrete structures without any skilled laborers for concrete placement. An extensive literature survey was conducted to explore the present state of knowledge on the durability performance of self compacting concrete. This paper mainly presents the durability of self compacting concrete with respect to corrosion, freeze-thaw cycles, sulfate attack, and alkali-aggregate reactions. In addition, this paper briefly discusses the effects of porosity, electrical resistivity, transport properties, drying shrinkage, segregation resistance, and air content on the durability performance of self compacting concrete.

Paratibha aggarwal, rafat siddique (2008) 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, compact ability 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 self-compacting concrete mixes. The test results for acceptance characteristics of self-compacting concrete such as slump flow; V-funnel are presented. Further, compressive strength at the ages of 7, 28, and 90 days was also determined are included here.

3. EXPERIMENTAL PROGRAM

This experiment studies the strength characteristic of self compacting concrete that containing cement with addition of marble powder of (20%, 30%, 40%,50%) and silica fume of (5%). The studies were carried out using types of marble powder % with the constant silica fume %. With mix proportional of cement, fine aggregate, coarse aggregate and water and super plasticizer. The concrete mix casted in moulds and kept for curing in water. The Compressive strength, flexural strength, split tensile strength were conducted for 7 days and 28 days.

Table 1 Mix proportions for

S.NO	MATERIALS	QUANTITY(kg/m^3)
1	Cement	450
2	Marble powder	(20%, 30%, 40%, 50%) of powder
3	Silica fume	5% of powder
4	Fine aggregate	870
5	Coarse aggregate	780
6	Super plasticizer	1.5% of powder
7	Water	0.26 of powder

Description of Specimens

- **M 1**: Cement +5% of silica fume +20% of Marble powder
- **M 2**: Cement +5% of silica fume +30% of Marble powder
- **M 3**: Cement +5% of silica fume +40% of Marble powder
- **M 4**: Cement +5% of silica fume +50% of Marble powder

4. MATERIALS

1. **CEMENT:** Cement can be defined as material having adhesive and cohesive properties which make it capable of bonding material fragments into a compact mass. Cement is the most important ingredient in concrete. Different brands of cement have been found to possess different strength development characteristics and rheological behavior due to the variations in the compound composition and fineness. For the present investigation, ordinary Portland cement grade conforming to IS 12269-1987 was used.
2. **MARBLE POWDER**: The advancement of concrete technology can reduce the consumption of natural resource and energy source and lessen the burden of pollution on environment .Presently Large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble dust in concrete production as partial replacement of cement. In INDIA, the marble and granite stone processing is one of the most thriving industry the effects if varying marble dust content on the physical and mechanical properties of fresh and hardened concrete have been investigated. specific gravity of marble powder used .
3. **SILICA FUME**: Silica fume imparts very good improvement to rheological, mechanical and chemical properties. It improves the durability of the concrete by reinforcing the microstructure through filler effect and thus reduces segregation and bleeding. It also helps in achieving high early strength. Silica fume of specific gravity was used in this study.

Properties of Cement, Marble powder and Silica fume

TABLE 1

Property	Cement	Marble powder	Silica fume
Specific gravity	2.22	2.84	2.31
Bulk density Kg/m3	500-800	1100	600-900
appearance	grey	pearl white	grey
Particle size	30 microns	25 microns	25 microns
Fineness(m2/kg)	350	380	365

4. **FINE AGGREGATE**: The fine aggregate used in the investigation is clean river sand and conforming to zone II. The sand was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm. Particles smaller than 0.125mm (125µ) size are considered as fine which contribute to the powder content. Fine aggregates shall conform to the required of IS 383.

Properties Of Fine Aggregates

TABLE 2

Property	Value
Size	4.75mm
Bulk Density	1850lg/m3
Specific gravity	2.55
Fineness modulus	3.35
Water Absorption	1.90%

5. **COARSE AGGREGATE**: The coarse aggregate used in the investigation is crushed stone aggregate passing through 20mm sieve. The aggregate occupy 70%-80% of the total volume normal concrete. But self-compacting concrete have only 50% of total volume of concrete. Coarse aggregate shall comply with the requirement of IS 383-1970.

Properties Of Coarse Aggregates

TABLE 3

Property	Value
Size	20mm
Shape	irregular
Specific gravity	2.87
Abrrasion	27.58%
Water Absorption	0.50%
Crushing value	14.22%

6. **SUPERPLASTICIZER**: The superplasticizer is an essential component of self compacting concrete to provide the necessary workability, Conplast Sp 430 is used.

5. TEST RESULTS

Compressive Strength: units (N/mm^2):

Compressive strength is the tendency of structure to with resist loads tending to reduce size, as counter to tensile strength, which supports loads tending to expand. In present trends, compressive strength resists compression where as tensile strength resists tension. In the present study spilt tensile strength, compressive strength, and bending strength can be analyzed accordingly.

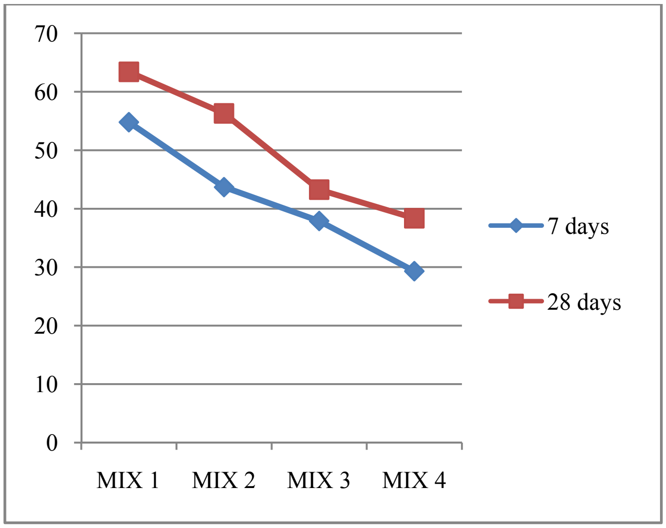

Figure 1: Compressive Strength

Split Tensile Strength: units (N/mm^2):

The spilt tensile strength of concrete is one of the prior properties. Splitting tensile strength test on self compacing concrete casted cylinders are used determine the tensile strength of self compacing concrete. The self compacting concrete is slightly weak in tension due to its brittleness nature and is not dreamt to resist the tension directly.

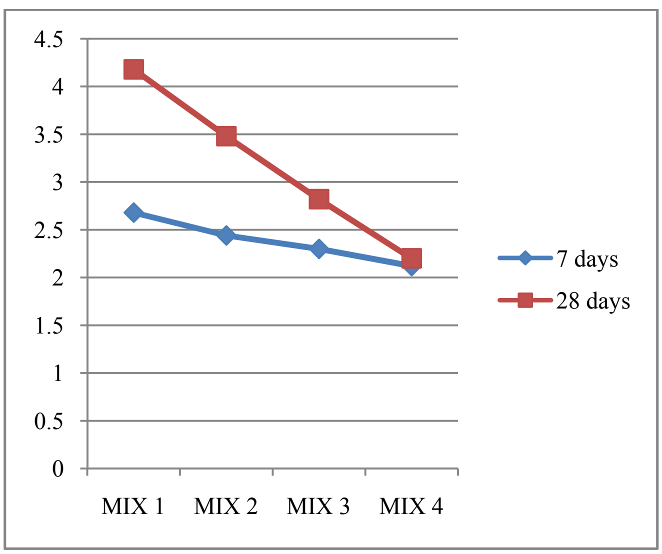

Figure 2: Split Tensile Strength

Flexural Strength:

Flexural strength is one measure of the bending strength of self compacing concrete. It is a measure of an unreinforced concrete beam or slab to resist rupture in bending. It is measured by loading (**100x100x 500mm**) concrete beams with a span length of at least three times the depth.

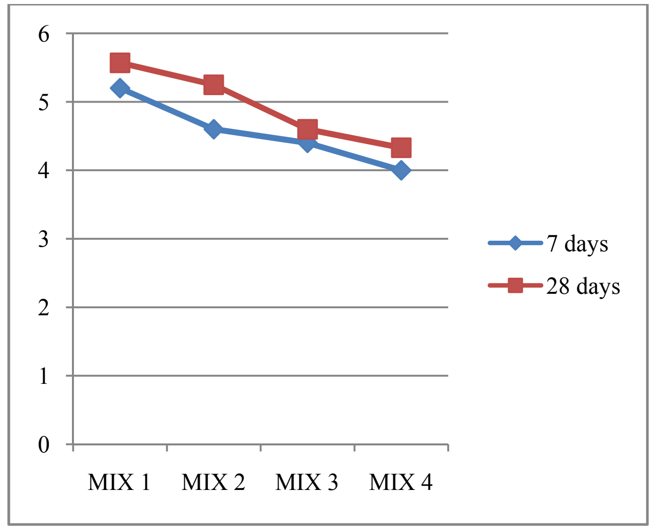

Figure 3: Flexural Strength

6. CONCLUSIONS

Increase in 15.67% of Compressive strength has been observed between 28 days & 7 days nominal mix (mix1).

Increase in 30.78% of Compressive strength has been observed between 7 days & 28 days optimal mix (mix4).

Increase in 55.9% of Split Tensile strength has been observed between 7 days optimal mix (Mix1) & 28 days optimal mix (Mix1).

Increase in 14.13% of Flexural strength has been observed between 7 days optimal mix & 28 days optimal mix(Mix2).

Rheological properties of all mixes with varying marble powder content are under EFNARC (2002) guidelines.

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