EXPERIMENTAL STUDY OF SELF COMPACTING CONCRETE ON INDUSTRIAL WASTE

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ABSTRACT

Self-compacting concrete (scc) is a modern and innovative concrete that does not need vibration for placement and compaction. It is also known as flowable, self- consolidating, and non-vibration concrete. It is enormously consistent and highly flowable, without the loss of stability, and moreover it can flow due to its weight, fill the formwork and achieve complete compaction even in the presence of crowded reinforcement. After solidification, it is hard, consistent, and has similar engineering characteristics, including strength, as conventional concrete that has been vibrated. Therefore after hardening, its function is like normal (vibrated) concrete. Self-consolidating concrete (scc) has a fast rate of concrete placement, with a swift flow close to the congested reinforcement region. This enables the achievement of rapid construction. The resistance to segregation and high fluidity ensures homogeneity, minimum voids, and a consistent concrete strength. These characteristics provide excellent durability and finish to the building. The mixture is produced with a low ratio of water and cement that makes the concrete have a high strength. Furthermore, the exclusion of vibrating machinery assists in a clean environment near the construction site. The workers also do not have to bear the uncomfortable noise created due to vibration. Some areas where concrete is poured have spaces that are congested with reinforced bars, and placing normal concrete in such locations is difficult.

Keywords: Self-consolidating concrete, solidification and Industrial waste.

INTRODUCTION

Self- compacting concrete can conveniently be used for complex shapes, narrow shells, and where conventional vibration may not be possible. Use of normal concrete at such places can cause voids that are undesirable. Self-compacting concrete(scc) is especially useful for structures that require a high quality, with no deviation in color, texture, and smoothness. However, the use of this type of concrete is limited due to its high cost (Dinakar *et al.*, 2008).

The 3 main properties of SCC in plastic state are

Filling ability: Self compacting concrete must be able to flow into all the spaces within the formwork under its own weight. This is related to workability, as measured by slump flow or Orimet test. The filling ability or flowability is the property that characterizes the ability of the SCC of flowing into formwork and filling all space under its own weight, guaranteeing total covering of the reinforcement. The mechanisms that govern this property are highfluidity and cohesion of the mixture (**Barros *et al.*, 2007**).

Passing ability: Self compacting concrete must flow through tight openings such as spaces between steel reinforcing bars under its own weight. The mix must not 'block' during placement. The passing ability is the property that characterizes the ability of the SCC to pass between obstacles- gaps between reinforcement, holes, and narrow sections, without blocking. The mechanisms that govern this property are moderate viscosity of the paste and mortar, and the properties of the aggregates, principally, maximum size of the coarse aggregate.

High Resistance to Segregation: Self compacting concrete must meet the requirements of 1 and 2 while its original composition remains uniform. The key properties must be maintained at adequate levels for the required period of time (e.g.20 min) after completion of mixing. It is property 2 the passing ability and property 3 resistance to segregation that constitute the major advance, form a merely super plasticized fresh mix which may be more fluid than self compacting concrete mix.

Latest developments in accordance with the objectives of the European SCC project aim to limit the admixtures used for general purpose SCC s to only one by using new types and combinations of polymers. Experience has shown that such an admixture may have to add to generate and maintain compacting concrete using less liable materials (**Dawood and ElGawady, 2013**). This study about the industrial waste which helps to increase the strength of self-compacting concrete.

METHODOLOGY

The step by step methodology for the work to be carried out and the futurework to be done further has been provided as a theory explaining the whole process. The flow chart has also been included in the form of a process chart for the betterunderstanding of the process in a precise manner.

A collection of literature review was done to understand the concept of current development and properties of self compacting concrete in construction field. How the workability and usage is have also been studied. The next part from my side isto study about some of the industrial waste which is been exposed in big volumes, collect data and studying about their characteristics which should help gaining strength in theself compacting concrete. When two or plus wastes are found it will be blended into the Self compacting concrete and the cube samples are made. Then after it crosses the curing stage, all the cube samples will be tested for compression test in the lab. By this I find which sample performance the best by showing its durability. Based on the test results, it will be planned in which area of construction will it be suitable. Also by this experiment the main task gets satisfied, that is huge amount of industrial waste which is been exposed to environment by the industries creates a harmfulatmosphere. But by this experiment it will be solved when it is implemented in the mixing of self compacting concrete (ElGawady and Sha'lan , 2011).

Self Compacting Concrete and Measurement of It's Flow Properties: This is simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat unwieldy and level ground is essential. It is most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. It can be argued that the completely free flow, unrestrained by any boundaries, is not representative of what happens in practice in concrete construction, butthe test can be profitably be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.

U BOX TEST METHOD: This is a simple test to conduct, but the equipment may be difficult to construct. It provides a good direct assessment of filling ability-this is literally what the concrete hasto do-modified by an unmeasured requirement for passing ability. The 35 mm gap between the sections of reinforcement may be considered too close. The question remains open of what filling height less than 30 cm. is still acceptable (**Felekoglu, 2007**).

L BOX TEST METHOD: This is widely is used test, suitable for laboratory, and perhaps site use. It assesses filling and passing ability of SCC, and serious lack of stability (segregation) can be detected visually. Segregation may also be detected by subsequently sawing and inspecting sections of the concrete in the horizontal section. Unfortunately there is no agreement on materials, dimensions, or reinforcing bar arrangement, so it is difficult to compare test results.

There is no evidence of what effect the wall of the apparatus and theconsequent 'wall effect' might have on concrete flow, but this arrangement does, to some extent, replicate what happens to concrete on site when it is confined within formwork. Two operators are required if times are measured, and a degree of operator error is inevitable (Gartner, 2004).

V FUNNEL TEST: Though the test is designed to measure flow ability, the result is affected by concrete properties other than flow. The inverted cone shape will cause any liability of the concrete to block to be reflected in the result – if, for example there is too much coarse aggregate. High flow time can also be associated with low deformability due to high paste viscosity, and with high inter-particle friction.

Granite and marble process industry generates a large amount of wastes mainly in the form of powder during sawing and polishing processes, which pollute and damage the environment. Therefore, this work aims to characterize and evaluate the possibilities of using the granite and marble sawing wastes, generated by the process industries from Nazarethpet, Ambattur as alternative raw materials in the production of Self compacting concrete by partial replacement of sand (Fig 1 and Table 1).

Fig 1. Granite powder

Table 1. Chemical oxide composition in granite powder:

Constituent	Value(%)
SiO_2	72.04%
Al_2O_3	14.42%
Na_2O	3.69%
CaO	1.82%
FeO	1.68%
Fe_2O_3	1.22%

Granite quarry sludge is the waste from rock processing in quarries and crusher units. The fines are at present disposed by filling in barren land causing serious environmental issues. If this material is possible to be used for partial cement replacement it is of benefit both economically and environmentally. The effect on strength properties of concrete in replacing some portion of sand by Granite quarry powder obtained from a local crusher unit is analyzed. The research work carried out included an experimental investigation on strength properties of concrete made with 10% replacement of sand by Granite quarry dust of less than 75 micron particle size. The tests were carried out to find the compressive strength, splitting tensile strength and specimens. Results showed that up to 10 % replacement of sand by Granite quarry dust there was no reduction in compressive strength, split tensile strength (Corinaldesi and Moriconi, 2004).

Every day about massive amount of lathe waste are generated by each lathe industries in the Ambattur industrial region and dumped in the barren soil there by contaminating the soil and ground water, which creates an environmental issue. Hence by adopting proper management by recycling the lathe scrap with concrete is considered to be one of the best solutions (Fig 2).

Fig 2. Lathe scrap powder partial replacement with sand

TANNING WASTE

Leather industry generates significant amounts of solid waste and industrial sludge. They originate from various technological steps of leather production, 1 mg of raw yields altogether about 700 kg of waste. Moreover, tannery waste contains chromium compounds, commonly used as tanning agents. This poses a further threat to the environment.Tannery industrial sludge since it is causing major problem to environment, this sludge when mixed into concrete as a partial replacement. Which is rich in fiber content washed away from tannery industries. These fiber content present in the sludge helps to increase the compressive strength of the concrete (Bassuoni and Nehdi, 2007).

A viscosity modifying admixture called GLENIUM STREAM2 was used to induce the flow without segregation. GLENIUM STREAM 2 is dosed at the rate of 50ml of cementitious material. Other dosages may be recommended in special cases according to specific job site conditions. GLENIUM STREAM 2 consists of a mixture of water soluble polymers which is absorbed on to the surface of cement granules there by changing the viscosity of water and influencing the rheological properties of the mix. It also resist the segregation due aggregation of the polymer chains when the concrete is not moving. GLENIUM STREAM 2 is a chloride free admixture. It should be added to the concrete after all the other components of the mix. This is particularly important in order to obtain maximum efficiency. It is a colourless free flowing liquid. A high performance concrete superplasticizer based on modified polycarboxylic ether was used in the experimentation. The trade name of the superplasticizer is GLENIUMTM SKY 784. It greatly improves the cement dispersion. Optimum dosage of GLENIUMTM SKY 784 should be determined in trial mixes. As a guide a dosage range of 300ml cementitious material is normally recommended.

RESULTS

SCC containing the combination of admixtures (sp+vma) with various industrial wastes

The following tables 1-4 give the test results of effect of addition of industrial waste in self compacting concrete containing an admixture combination (SP+VMA). Compressive strength test results of self compacting concrete containing the combination of admixtures (SP+VMA) with 10% industrial wastes.

Table 2. Compressive strength of SCC at with 10% of Tanning waste and withcombination of admixtures (SP+VMA)

Specimen identification	Weight of specimen (N)	Density (N/cum)	Failure Load (K/N)	Compressive strength(MPa)	Test Days
T1	60.8	2020	430	19.10	7th day
T2	66.6	2020	580	25.8	14th day
T3	73.5	2020	620	27.60	24th day

Table 3. Compressive strength of SCC with 10% of Lathe waste and withcombination of admixtures (SP+VMA)

Specimen identification	Weight of specimen (N)	Density (N/cum)	Failure Load (K/N)	Compressive strength (MPa)	Test days
L1	65.7	2020	540	24.0	7th day
L2	68.6	2020	670	29.8	14th day
L3	72.5	2020	900	31.20	24th day

Table 4. Compressive strength of SCC with 10% of Granite powder and withcombination of admixtures (SP+VMA)

Specimen identification	Weight of specimen (N)	Density (N/cum)	Failure Load (K/N)	Compressive strength (MPa)	Test days
G1	74.5	2020	780	19.10	7th day
G2	78.4	2020	823	36.6	14th day
G3	85.3	2020	900	40.4	24th day

Overall results of compressive strength

The following table no 5-8 gives the overall results of compressive strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various Industrial wastes

Table 5. Overall Results of compressive strength

Specimen identification	Average compressive strength
Tanning waste T1,T2,T3	24.16
Lathe waste L1,L2,L3	28.6
Marble powder G1,G2,G3	24.61

Table 6. Tensile strength of SCC with combination of admixture and 10% Tanningwaste

Specimen Identification	Failure Load (KN)	Tensile strength $F=2P/\pi DL$
T1	250	3.53
T2	240	3.39
T3	220	3.11

Table 7. Tensile strength of SCC with combination of admixture and 10% of Lathewaste

Specimen identification	Failure load (KN)	Tensile strength F=2P/πDL
L1	250	4.52
L2	240	3.11
L3	320	3.53

Table 8. Tensile strength of SCC with combination with admixture and 10% ofMarble powder

Specimen identification	Failure load (KN)	Tensile strength F=2P/πDL
M1	330	4.95
M2	300	4.24
M3	350	4.67

OVERALL RESULTS OF TENSILE STRENGTH

The following table no 9 gives the overall results of compressive strength of self compacting concrete containing the combination of admixtures (SP+VMA) for various Industrial wastes

Table 9. Overall Results of Tensile strength

Specimen identification	Average tensile strength (mpa)
Tanning sludge waste (T1,T2,T3)	3.34
Lathe waste (L1,L2,L3)	3.72
Granite powder (G1,G2,G3)	4.5

FLOW TEST RESULTS

The following tables 10-13 give the flow test results of effect of addition of industrial wastes on the properties of self compacting concrete containing an admixtures combination of (SP+VMA)

Table 10. Slump flow test results

Percentage of different industrial waste	Slump flow (mm)	Time in sec
10% of Tannery sludge waste	560	13.2

Percentage of different industrial waste	Slump flow (mm)	Time in sec
10% of Lathe powder waste	480	15.6
10% of Granite powder	680	5.8

Table 11. V – Funnel test results

Percentage of different industrial waste	Flow time in sec
10% of Tannery sludge waste	33.6
10% of Lathe powder waste	38.12
10% of Granite powder	25.1

Table 12. U – Box test results

Percentage of different Industrial wastes	Height of conc. In 1st compartment H1 (mm)	Height of conc. In 2st compartment H2 (mm)	Filling height H1-H2 (mm)
10% of Tannery sludge waste	290	270	10
10% of Lathe powder waste	290	285	15
10% of Granite powder	290	290	22

Table 13. L – Box test results

Percentage of different industrial wastes	Height H1	Height H2	Blocking ratio H2/H1	Time taken for conc. To reach a distance of 200 mm	Time taken for conc. To reach a distance of 400 mm
10% ofTannery sludge waste	80	76	0.96	3.80	6.5
10% ofLathe powder waste	70	60	0.85	4.60	8.8
10% ofGranite powder	82	48	0.70	6.30	13.4

Cost comparison between Normal SCC and Industrial waste blended SCC

From the above experimental procedures conducted in Self compacting concrete by blending industrial waste, a cost comparison is done between normal self compacting concrete and industrial waste blended self compacting concrete. For a volume of 100 cftthe below calculation is done (table 14).

Table 14. Cost analysis

Normal SCC		**Industrial waste blended SCC**	
Cement	RS 7360	Cement	Rs 7360
Sand 42 cft	Rs 2300	Sand 35 cft with 15 % replacement of industrial waste	Rs 1925
Aggregate 20 mm	Rs 2352	Aggregate 20 mm	Rs 1680
Total	Rs 12,000	Total	Rs 10,965

CONCLUSION

In present scenario there is a greater need for self compacting concrete due to sickness of member and architectural requirement, also to improve durability of the structure. Now the world is going to facing greater need of high performance concrete, durability point of view and SCC where the conventional way of compacting may not be always useful under different site condition. So instead of going for the conventional concrete let us mix the concrete compacting on its own which is called as self compacting concrete. Now due to industrialization there is greater increase in the industrial wastes like Tannerysludge, Lathe powder waste, Granite quarry powder etc in and around Chennai.

This waste is used for dumping for filling the low lying areas causing the environment in deterioration in long run, so this mix should be used for the construction activity it will reduce the problem of environmental pollution at the same time it reduces the cost of the construction and add it makes the concrete high performing from the durability point of view. So from these three points the project is under taken. Based on the experimentation conducted, the following observations were made and hence someconclusions. It has been observed that the compressive strength of self compacting concrete produced with the combination of admixtures such as

(SP+VMA) goes on increasing upto 15 % of industrial waste . After 15% addition of industrial waste , the compressive strength starts increasing, i.e. the compressive strength of self compacting concrete produced with (SP+VMA) is maximum when 15 % industrial waste. The percentage increase in the compressive strength at15% addition of industrial waste. Thus, it can be concluded that maximum compressive strength of self-compacting concrete with the combination of admixtures (SP+VMA) may be obtained by adding 15% of industrial waste.

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