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Fresh And Hardened Properties of SCC Made with Combined Use of M-Sand and Marble Powder

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Abstract—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. Marble has been used as an important building material, especially for decorative purposes for centuries. During sawing, shaping and polishing process, about 25% of the processed marble turns into dust or powder form. It is obvious that the waste material of these plants reaches millions of tons, thus making the stocking of this amount of waste impossible. Common river sand is expensive due to excessive cost of transportation from natural source. Also large scale depletion of this source creates environmental problem. Environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry need to be found. The production of M-Sand also generates high percentages of micro fines, particles that pass the 75μsieve, ranging from 5% to 20%. In the present investigation, micro level materials such as Marble Powder (MP) are used to replacement of cement. Fine aggregate are replaced by Manufacturing Sand (M-Sand) and their physical properties were determined.It has been observed that at optimum value of 75% M-sand and 5% Marble powder, the compressive strength was increased by 17.37%, the tensile strength was increased by 53.6% and the flexural strength was increased by 20.64%.

Keywords—Marble Powder, Super Plasticizer, M-sand

I. INTRODUCTION

The development of new technology in the material science is progressing rapidly. In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability. In recent years, a lot of research was carried out throughout the world to improve the performance of concrete in terms of its most important properties i.e. strength and durability. Concrete technology has under gone from macro to micro level study in the enhancement of strength and durability properties from 1980's onwards. Till 1980 the research study was focused only to flow ability of concrete, so as to enhance the strength however durability did not draw lot of attention of the concrete technologists.

This type of study has resulted in the development of self compacting concrete (SCC), a much needed revolution in concrete industry. Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties. This concrete was first developed in Japan in late 80's to combat the deterioration of concrete quality due to lack of skilled labors, along with problems at the corners regarding the homogeneity and compaction of cast in place concrete mainly with intricate structures so as to improve the durability of concrete and structures.

Self compacting concrete is basically a concrete which is capable of flowing in to the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. There is no standard self compacting concrete. Therefore each self-compacting concrete has to be designed for the particular structure to be constructed. However working on the parameters which affect the basic properties of self-compacting concrete such as plastic viscosity, deformability, flow ability and resistance to segregation, self-compacting concrete may be proportioned for almost any type of concrete structure. To establish an appropriate mixture proportion for a self compacting concrete the performance requirements must be defined taking into account the structural conditions such as shape, dimensions, reinforcement density and construction conditions. The construction conditions include methods of transporting, placing, finishing and curing. The specific requirement of self-compacting concrete is its capacity for self-compaction, without vibration, in the fresh state. Other performances such as strength and durability should be established as for normal concrete. To meet the concrete performance requirements the following three types of self-compacting concretes are available.

a) Powder type of self-compacting concrete:

This is proportioned to give the required self-compact ability by reducing the water-powder (material<0.1mm) ratio and provide adequate segregation resistance. Super plasticizer and air entraining admixtures give the required deformability.

b) Viscosity agent type self-compacting concrete:

This type is proportioned to provide self-compaction by the use of viscosity modifying admixture to provide segregation resistance. Super plasticizers and air entraining admixtures are used for obtaining the desired deformability.

c) Combination type self-compacting concrete:

This type is proportioned so as to obtain self-compactability mainly by reducing the water powder ratio, as in the powder type, and a viscosity modifying admixture is added to reduce the quality fluctuations of the fresh concrete due to the variation of the surface moisture content of the aggregates and their gradations during the production. This facilitates the production control of the concrete.

II. NEED FOR SCC

The SCC concept can be stated as the concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedure and curing practices. The SCC is an engineered material consisting of cement, aggregates, water and admixtures with several new constituents like colloidal silica, pozzolanic materials, chemical admixtures to take care of specific requirements, such as, high-flow ability, compressive strength, high workability, enhanced resistances to chemical or mechanical stresses, lower permeability, durability, resistance against segregation, and possibility under dense reinforcement conditions.

The properties, such as, fluidity and high resistance to segregation enables the placement of concrete without vibrations and with reduced labour, noise and much less wear and tear of equipment. Use of SCC overcomes the problem of concrete placement in heavily reinforced sections and it helps to shorten construction period. Self-compacting concrete is growing rapidly, especially in the precast market where its advantages are rapidly understood and utilized.

III. MATERIALS FOR SCC

SCC is something different than the conventional concrete or modification of conventional concrete it has similar ingredients such as aggregate binder, however there blending is changed so as to get the advantage of self compactness

Cement : Generally Portland cement is used for SCC.

Aggregates : The maximum size of aggregate is generally limited to 20mm aggregate of size 10 mm is desirable for structures having congested reinforcement. Where ever possible size of aggregate higher than20 mm could also be used. Well graded cubical or rounded aggregate are desirable. Aggregates should be of uniform quality with respect to shape and grading. Fine aggregate can be natural or manufactured. The grading must be uniform throughout the work. The moisture content or absorption characteristics must be closely monitored as quality of SCC will be sensitive to such changes. Particles smaller than 0.125mm i.e. 125 micron size are considered as FINES which contribute to the powder content.

Mixing water : Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen.

Admixtures for SCC : An admixture is a material other than water, aggregates and cement and is added to the batch immediately before or during its mixing. Admixtures are used to improve or give special properties to concrete. The use of admixture should offer an improvement not economically attainable by adjusting the proportions of cement and aggregates and should not adversely affect any properties of the concrete. The admixture consist chiefly of those which accelerate and those which retard hydration or setting of the cement, finely divided materials which improves workability, water proofers, pigments, wetting, dispersing and air-entraining agents and pozzolanas.

Chemical Admixtures: Super plasticizer AEROMIX-800 is used because it is essential component of SCC to provide necessary workability.

Mineral Admixtures

Marble powder : Marble powder can be used in appropriate quantity to improve the quality and durability of SCC.

Manufactured Sand

M-Sand is manufactured sand. M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. M-Sand is superior quality manufactured sand with international standards. However, many people in India have doubts about quality of concrete / mortars when manufactured or artificial sand are used. Manufactured sand have been regularly used to make quality concrete for decades in India and abroad.

IV. EXPERIMENTS AND RESULTS

The field of concrete technology has seen miraculous changes due to the invention of various admixtures. The admixtures modify the properties of fresh concrete and offer many advantages to the user. The main aim of this experimentation is to find out the effect of addition of Marble powder, and M-Sand, on the properties of self compacting concrete containing admixtures. In this experimentation admixtures which is taken-.Super plasticizer .The flow characteristics and strength characteristics of self compacting concrete produced from different waste material and different percentages of that material are found. The different percentages of M-Sand used in experimentation are 0%, 25%,50%,75%,100% and the different percentages of marble powder used in experiment are 0%, 1%, 2%, 3%, 4%, 5%, and 6%.

The main aim of this experimentation is to find out the effect of addition of Marble powder, and M-sand on the properties of self compacting concrete. In this experimentation combinations of admixtures which is taken-.Super plasticizer .The flow characteristics and strength characteristics of self compacting concrete produced from different material and different percentages of that material are found.

The cement, sand and coarse aggregates were weighed according to the mix proportion 1:1:0.5. The fly ash and cement proportion used in the experimentation was 1:3.5. To this dry mix the required quantity of Marble powder (0%,1%, 2%, 3%, 4%, 5%, and 6%) was added and homogenously mixed. To this dry mix the required quantity of water was added and thoroughly mixed. To this the super-plasticizer was added at the rate of 700ml/100Kg of cementitious material and mixed intimately. Now the viscosity modifying agent (VMA) was added at the rate of100ml/100Kg of cementitious material. The entire mix was thoroughly mixed once again. At this stage, almost the concrete was in a flow able state. Now, the flow characteristic experiments for self compacting concrete like slump flow test, V-funnel test, L-box test and U-box test were conducted.

After conducting the flow characteristic experiments the concrete mix was poured in the mould required for the strength assessment. After pouring the concrete into the moulds, no compaction was given either through vibrated or through hand compaction. Even the concrete did not require any finishing operation. After 24 hours of casting, the specimens were demoulded and were transferred to the curing tank wherein they were allowed to cure for 28 days. For compressive strength assessment, cubes of size150mmX150mmX150mm were prepared. For tensile strength assessment, cylinders of diameter 150mm and length 300mm were prepared. Indirect tension test (Brazilian test or split tensile test), was carried on these cylindrical specimens. For flexural strength assessment, the beams of size 100mmX100mmX500mm were prepared and two point loading on an effective span of 400mm was adopted. After 28 days of curing the specimens were tested for their respective strengths.

A. *Test Results of Control mix*

Fresh properties of control mix

Control Mix	Readings	As per IS 456-2000 limitation
Slump flow diameter (mm)	730	650-800
Slump flow time (sec)	5.077	2-5
V-funnel flow time(sec)	6.42	8-12
L-box(h_2/h_1)	0.83	0.8-1.0

Compressive strength of control mix

Days	Compressive strength(N/mm^2)
7	36.44
14	40
28	46.67

Tensile strength of control mix

Days	Tensile strength(N/mm^2)
7	2.26
14	2.83

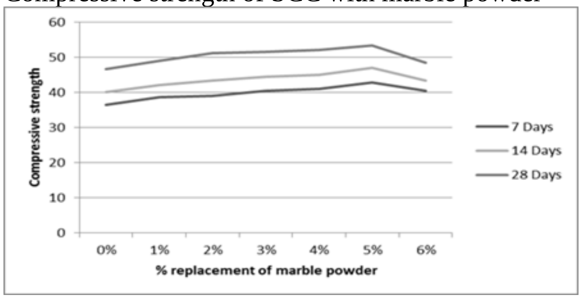
28	3.32

Flexural strength of control mix

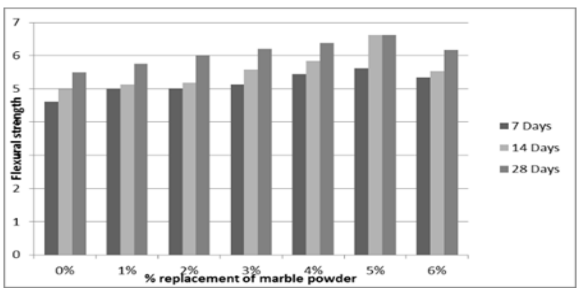
Days	Flexural strength(N/mm^2)
7	4.625
14	5
28	5.5

B. Test Results with marble powder

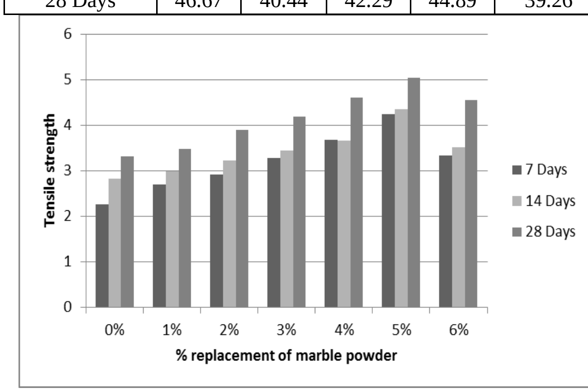
Compressive strength of SCC with marble powder



% Replacement of Marble Powder	0%	1%	2%	3%	4%	5%	6%
7 Days	36.4	38.5	39.0	40.3	40.8	42.7	40.39
14 Days	40	42	43.3	44.3	44.9	46.9	43.38
28 Days	46.6	48.8	51.1	51.5	52.0	53.3	48.44



% Replacement of M-sand	0%	25%	50%	75%	100%
7 Days	36.44	33.33	34.22	35.56	32.88
14 Days	40	36.44	36.89	38.67	35.56
28 Days	46.67	40.44	42.29	44.89	39.26



Flexural strength of SCC with marble powder

Tensile strength of SCC with marble powder

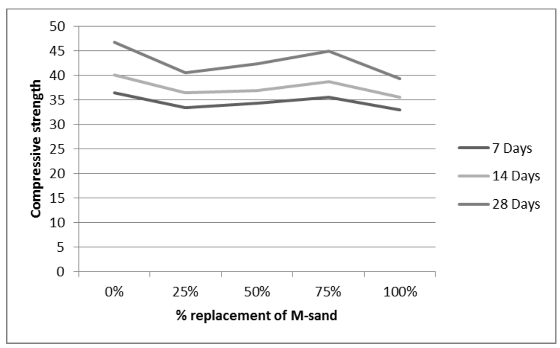
% Replacement of Marble Powder	0%	1%	2%	3%	4%	5%	6%
7 Days	2.26	2.69	2.92	3.28	3.68	4.25	3.33
14 Days	2.83	2.98	3.22	3.45	3.66	4.35	3.51
28 Days	3.32	3.48	3.89	4.19	4.60	5.04	4.55

Percentage replacement M-Sand	0%	25%	50%	75%	100%
7 Days	2.26	1.69	1.84	2.12	1.56
14 Days	2.83	2.26	2.40	2.55	1.98
28 Days	3.32	2.88	3.11	3.23	2.69

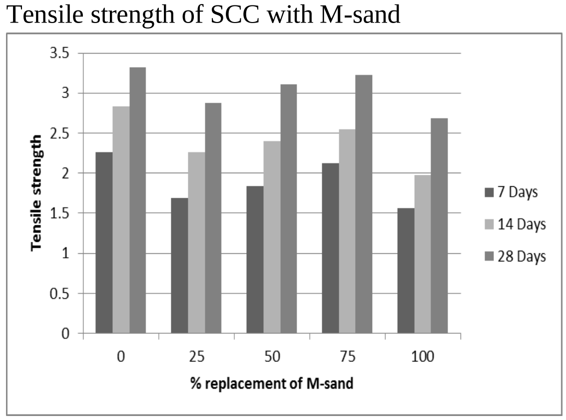
% Replacement of Marble Powder	0%	1%	2%	3%	4%	5%	6%
7 Days	4.62	5.00	5.01	5.14	5.45	5.62	5.3
14 Days	5.00	5.14	5.18	5.59	5.84	6.62	5.5
28 Days	5.50	5.75	6.00	6.21	6.37	6.62	6.1

C. Test Results with M- Sand

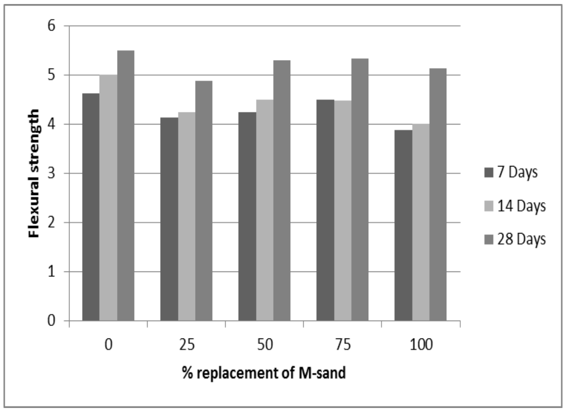
Compressive strength of SCC with M-sand



Tensile strength of SCC with M-sand



Flexural strength of SCC with M-sand



D. Test Results of Optimum mix

The optimum mix is obtained by the replacement of 75% M-Sand in river sand and 5% of marble powder in cement.

Fresh properties of optimum mix

75% M-sand& 5% Marble Powder	Readings
Slump flow (mm)	740
Slump flow(sec)	4.85
V-funnel flow time(sec)	5.85
L-box(sec)	2.40

Compressive strength of optimum mix

Percentage of replacement	75 % M-Sand & 5% Marble Powder
7 days	44.89
14 days	47.92
28 days	54.78

Tensile strength of optimum mix

Percentage of replacement	75 % M-Sand & 5% Marble Powder
7 days	4.30
14 days	4.42
28 days	5.10

Flexural strength of optimum mix

Percentage of replacement	75 % M-Sand & 5% Marble Powder
7 days	5.725
14 days	6.425
28 days	6.635

V. 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. Based on the experimentation conducted, the following observations were made and hence some conclusions were obtained. It has been observed that at optimum value of 75% M-sand and 5% Marble powder, the compressive strength was increased by 17.37%, the tensile strength was increased by 53.6% and the flexural strength was increased by 20.64%.

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Percentage replacement of M-Sand	0%	25%	50%	75%	100%
7 Days	4.625	4.125	4.25	4.5	3.875
14 Days	5	4.25	4.5	4.475	4
28 Days	5.500	4.875	5.290	5.333	5.125

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