ISSN 2250-3153

Experimental investigation on Self-Curing Self-Compacting Concrete by Replacing Natural Sand by M-sand and Coarse aggregates By Light Weight Aggregate for M-40 Grade Concrete

Mr. Sanjay raj A [*], Yogananda N[**]

[*] Asst. Professor, REVA Institute of Technology and Management, Bangalore- 560064.
[**] PG Student, REVA Institute of Technology and Management, Bangalore-560064

Abstract- In recent years, self-compacting concrete (SCC) has gained wide use for placement in congested reinforced concrete structures with difficult casting conditions. For such applications, the fresh concrete must possess high fluidity and good cohesiveness. In this present study, the effect of replacing the cement, fine aggregate and coarse aggregate by constant replacement of silica fume, Manufactured sand (JSW) replacement of 0%, 10%, 20%, 30%, 40% and light weight aggregate replacement of 10%, 15%, for internal curing respectively and their combinations of various proportions on the properties of different mixes of M40 grade has been compared with normal self compacting concrete by conventional curing method. In this study fresh property and hardened properties of the different mixes of concrete were determined. From the present study the test result showed that for fresh concrete all the mixes satisfies the EFNORC standard values. For harden concrete both compressive strength and split tensile strength test the M9 (30%relpacement FA and15% LWA) M4 (30% replacement FA and10% LWA) by internally curried concrete at ambient room temperature mixes gave highest values than the normal concrete by conventionally curing method.

Index Terms- SCC, Silica Fume, Light Weight Aggregate, and manufactured sand (JSW).

I. Introduction

Self Compacting Concrete (SCC) was first developed in 1988 by professor okamura intended to improve the durability properties of concrete structures. SCC is defined as concrete that is able to flow and consolidate under its own weight. SCC is consider to be one of the most successful innovation in industry of construction. Self-compacting concrete (SCC) is a highly flowable concrete which does not segregate and can spread into place, fill the formwork with heavily congested reinforcement without any mechanical vibration. In SCC, the aggregates contribute 60–70% of the total volume. Proper choice of aggregates has significant influence on the fresh and hardened properties of concrete. Aggregate characteristics such as shape, texture and grading influence workability, finish ability, bleeding, pump ability, segregation of fresh concrete and strength, stiffness, shrinkage, creep, density, permeability, and durability of hardened concrete. The advantages of SCC are: Improved quality of concrete and reduction of onsite repairs; Faster construction times; Lower overall costs; Facilitation of introduction of automation into concrete construction; Improvement of health and safety is also achieved through elimination of handling of vibrators; Possibilities for utilization of "dusts", which are currently waste products; Easier placing; Thinner concrete sections; Greater Freedom in Design. Many investigators [1-10] have studied about the manufacture sand. Strength characteristics of SCC and use of waste products such as silica fume and introduction of fibers in improving strength characteristics of SCC have been studied and reported in the literature.

Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. There are two major methods available for internal curing of concrete. The first method uses saturated porous lightweight aggregate (LWA) in order to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration. The second method uses poly-ethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention. In the present study the first method is being adopted. The use of fly ash, blast furnace slag and silica fume in SCC reduces the dosage of superplasticizer needed to obtain similar slump flow compared to concrete mixes made with only Portland cement.

II. OBJECTIVES OF THE STUDY

The main objective of this investigation is to determine the suitable percentage of manufacture sand (JSW), light weight aggregate replacement and influence of different proportioning of super plasticizers in SCC that gives the highest value of concrete compressive strength.

III. EXPERIMENTAL PROGRAM

In this investigation 99-cube, 99-cylinders are tested to investigate concrete compressive strength and split tensile strength of SCC with the combination of Manufactured sand, silica fume and light weight aggregate. All test specimens of cube with 150 mm size and cylinders with diameter 150 mm and 300 mm in length.

A. Materials used in this experiment

1) Cement (C)

In this experimental study, Ordinary Portland Cement conforming to IS: 8112-1989 was used. The physical and mechanical properties of the cement used are shown in Table 1.

Table 1: Properties of cement

Physical properties	Results
Fineness	2%
Normal consistency	30%
Vicat initial setting time(minutes)	30
Vicat final setting time (minutes)	205
Specific gravity	3.1

2) Light Weight Aggregate (LWA)

It is highly porous light weight aggregate. Its density is approximately 0.25g/cm^3. It is typically light colored and translucent bubble walls.

3) Silica Fume (SF)

Silica fume is a waste by-product of the production of silicon and silicon alloys. Silica fume is available in different forms, of which the most commonly used now is in a densified form. In developed countries it is already available readily blended with cement. The details of silica fume used in this experiment are in the Table.

Table-2: Details of Silica fume

Code	920-D
Type	Densified (Non-Combustible)
Main content	Amorphous Sio_2

4) Aggregates

Locally available natural sand with 4.75 mm maximum size was used as fine aggregate(FA). Coarse aggregate (CA) of maximum 12.5 mm was used. Table-3 gives the Physical properties of fine & coarse aggregate.

5) Super Plasticizer (SP)

Master glenium-Ace 30(JP) from BASF Bangalore was used.

Table-3 Physical properties of fine & coarse aggregate

Property	**Fine(FA)**	**Coarse(CA)**
Specific gravity	2.5	2.84
Fineness modulus	3.37	7.1
Surface texture	Smooth	--
Particle shape	Rounded	Angular
Crushing value	--	17.4
Impact value	--	12.5

6) Manufactured sand (JSW)

It's also one type of manufactured fine aggregate sand. Manufacture of SCC and conventional concrete is done using river sand. JSW slag is a by-product of metal smelting process that has been found to be suitable for producing M-sand as well as coarse aggregate. It has been used to replace River Sand during the manufacture of SCC.

Table-4: properties of manufactured sand

Physical properties	Test results
Specific gravity	2.58
Fineness modulus	3.37 (zone)

7) Water

Ordinary portable water is used.

B. SCC Mix Design

Several methods exists for the mix design of scc. We have adopted Nan-su method.

1) Mixing procedure for scc

Mixing procedure for scc is described as follows:

- Binder and aggregates are mixed for one minute.
- The 1st part (70%) of water was added and mixed for two minute.
- SP and VMA along with 2nd part (30%) of water was added and mixed for two minutes.
- The mix was stopped and discharged for SCC tests.

Table-5 Mixture proportion for SCC (M1-M10) (kg/m^3)

M1, M2, M3, M4, M5 are constant 10%LWA and 10%, 20%, 30%, 40% replacement of MS respectively.

M6, M7, M8, M9, M10 are constant 15%LWA and 10%, 20%, 30%, 40% replacement of MS respectively.

Table-5; Mix Proportions

S.N	C	S F	FA	MS	CA	LWA
NSC	394.28	172.46	821.02	0	638	0
M1	394.28	172.46	821.02	0	574.2	63.8
M2	394.28	172.46	738.91	82.1	574.2	63.8
M3	394.28	172.46	656.81	164.2	574.2	63.8
M4	394.28	172.46	574.71	246.3	574.2	63.8
M5	394.28	172.46	492.61	328.4	574.2	63.8
M6	394.28	172.46	821.02	0	542.3	95.7
M7	394.28	172.46	738.91	82.1	542.3	95.7
M8	394.28	172.46	656.81	164.2	542.3	95.7
M9	394.28	172.46	574.71	246.3	542.3	95.7
M10	394.28	172.46	492.61	328.4	542.3	95.7

IV. RESULT AND DISCUSSION

This chapter consists of test results and discussions on workability, compressive strength, split tensile strength Self compacting self curing Concrete (SCLC) for different fine Aggregate (Natural Sand) and coarse aggregate (LWA) replacement levels. The test results are compared with Normal Self compacting Concrete (NC).

A) Properties of Fresh state SCC

The workability is measured by flow properties as per EFNARC. The values of flow properties with constant water/binder ratio for Self compacting self curing concrete for different mixes were measured.

B) Properties of hardened SCC

The properties of hardened SCC was measured in terms of Compressive Strength obtained from Compression test confirming to IS 516-1959.Tests were conducted at different curing periods of 7, 28 and 56 days. The tensile strength is one of the basic and important properties of concrete. Hence, the tensile strength of concrete is obtained indirectly by subjecting concrete cylinders to the action of compressive force along two opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to the compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from the elastic analysis. The split tensile test is carried out as per IS: 5816-1970. The magnitude of tensile stress was evaluated using the relation σ_{SP} = 2P/ πDL = 0.637P/DL. The results of variation in compressive strength and tensile strength with various curing periods are as shown in table and figure.

Table-6; compressive strength

SI NO	parameter	Compressive Strength N/mm^2		
		7 days	28 days	56 days
1	NC	28.33	47.85	57.4
2	M1	28.92	48.54	58.37
3	M2	29.23	49.67	29.11
4	M3	29.78	50.05	59.74
5	M4	30.06	53.02	61.84
6	M5	29.67	50.52	59.97
7	M6	29.06	48.84	58.41
8	M7	29.89	49.96	59.38
9	M8	30.23	51.12	59.74
10	M9	30.78	53.98	62.58
11	M10	29.87	50.91	60.02

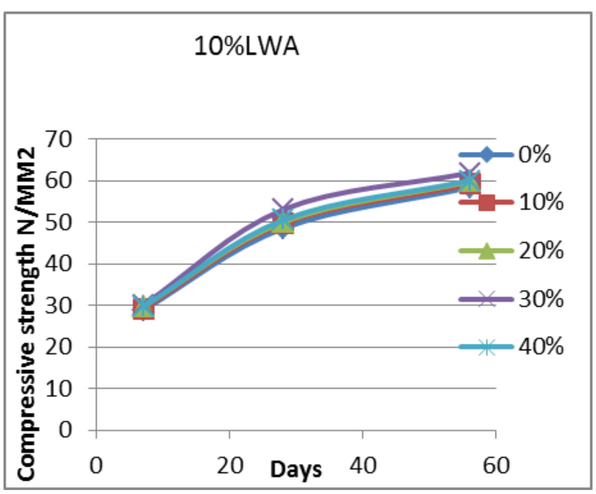

Figure 1: Compressive strength of 10% LWA

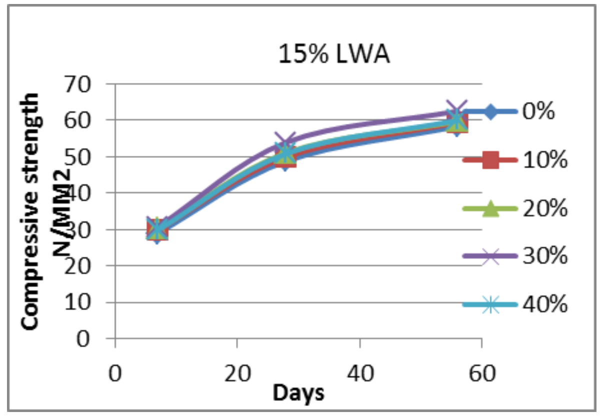

Figure 2: compressive strength 15% LWA

From the results obtained it can be observed that the compressive strength for internally cured at ambient temperature by replacing coarse aggregate by LWA as compared to that of NC increased strength reasonably. From the results obtained the cube compressive strength of the mixes. It can be seen that strength increases with constant replacement of silica and increasing percentage of JSW sand content 30%. The strength M1 to M5 ranges from 52MPa to 62 MPa and M6 to M10 ranges from 55 MPa to 63 MPa**.**

From the results obtained compressive strength of M4 having silica fume compared to NC was increased by 6%, 10%, 8% at 7-days, 28 days and 56 days respectively for 30% replacement of M-sand.

From the results obtained compressive strength of M9 having silica fume compared to NC was increased by 8%, 12%, 9% at 7-days, 28 days and 56 days respectively for 30% replacement of M-sand.

In this study an attempt for improving the harden characteristics of concrete by internally at ambient room temperature curing of concrete by partial replacement of coarse aggregate by LWA was studied. From the results obtained it shows that the compressive strength of concrete increased reasonably for all ages for M1 – M10 mixes.

The compressive strength of M9 increases by 2% than M4 at 28 days and M9 increases by 3% than M4 at 56 days. This study shows that the addition of M-sand beyond 30%compare to NC at ages reduce compressive strength.

Table 7: split tensile strength

SI NO	parameter	Tensile strength N/mm^2		
		7 days	28 days	56 days
1	NC	2.08	3.61	3.74
2	M1	2.18	3.63	4.17
3	M2	2.24	3.78	4.2
4	M3	2.4	3.84	4.38
5	M4	2.5	3.91	4.58
6	M5	2.34	3.76	4.29
7	M6	2.18	3.64	4.18
8	M7	2.31	3.73	4.35
9	M8	2.45	3.97	4.46
10	M9	2.52	4.18	4.69

11	M10	2.31	3.92	4.32

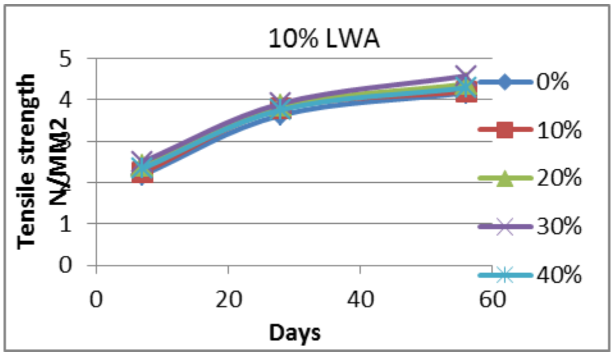

Figure 3: Split tensile strength 10% LWA

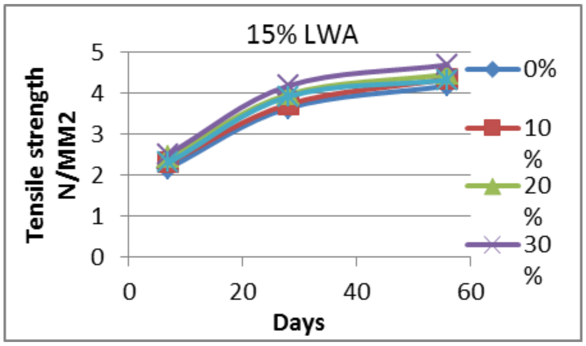

Figure 4: Split tensile strength 15% LWA

The strength M1 to M5 ranges from 4 MPa to 4.58 MPa and M6 to M10 ranges from 4.1 MPa to 4.7 MPa.

From the results obtained tensile strength of M4 having silica fume compared to NC was Increased by 20%, 8%, 11% at 7-days, 28 days and 56 days respectively for 30% replacement of M-sand.

From the results obtained split tensile strength of M9 having silica fume compared to NC was increased by 20%, 9%, 13% at 7-days, 28 days and 56 days respectively for 30% replacement of M-sand.

In this study an attempt for improving the harden characteristics of concrete by internally at ambient room temperature curing of concrete by partial replacement of coarse aggregate by LWA was studied. From the results obtained it shows that the split tensile strength of concrete increased reasonably for all ages for M1 – M10 mixes.

The tensile strength of M9 increases by 2% than M4 at 28 days and M9 increases by 3% than M4 at 56 days.

V. CONCLUSION

1. After designing the parameters of mix proportion of SCC mixes containing M-sand and LWA. A SCC with good workability and improved time dependent properties has been achieved and flow characteristics of SCC mixes for various proportions of M-sand and LWA were within prescribed limits as per EFNARC standards.

2. The result showed that both the flow ability and possibility measurement indicated that SCC mixes with replacement of material by M-sand and LWA was better as compared to that of control mix.

3. The compressive strength of SCC mixes containing M-sand, internally cured by replacement of coarse aggregate by LWA at ambient room temperature by replacement of coarse aggregate by LWA up to 30% replacement of M sand and later significantly decreased the strength as the percentage of M sand increased by beyond 30%.

4. The mechanical behavior of the SCC (M1-M10) mixes was attractive by internally curing compressive strength for M9 mixes was found to be 8%, 12%, and 9% for 7days 28days and 58days respectively for 15% replacement of LWA.

5. Research result demonstrated that application with SCC mixes containing Msand and LWA can be economical due to increase in the price of natural sand and scenario has risen which offer the final concrete products with interesting characteristics by using JSW M-sand a waste product and also can introduce innovative solution for specific application of using method.

ACKNOWLEDGMENT

1. I like to say thanks to Dr. W P Prema kumar and who helped me in carrying out this project.

2. I would like to thank Dr. Y Ramalinga reddy, H.O.D, civil dept. RITM, who helped me in my research work.

3. And I would like to thank all my friends in RITM for their support and suggestion.

REFERENCES

[1] Liberato Ferrara A.B. Yon-Dong Park B.C. Surendra P. Shah D. "A method for mixdesign of fiber-reinforced self-compacting concrete"

[2] D.D. Cortes, H.-K. Kim, A.M. Palomino, J.C. Santamarina. "Rheological and mechanical properties of mortars prepared with natural and manufactured sands"

[3] M.s. Ravikumar, selvamony c, s.u. kannan and s. basil gnanappa"Behaviour of self compacted self curing kiln ash concrete with various admixtures"

[4] Prakash Nanthagopalan, Manu Santhanam "Fresh and hardened properties of selfcompacting concrete produced with manufactured sand"

[5] C. Selvamony, M. S. Ravikumar, S. U. Kannan. and S. Basil Gnanappa. "Investigations on self-compacted self-curing concrete using limestone powder and clinkers"

[6] N. Siva Linga Rao,G. Venkata Ramana,V. Bhaskar Desai ,B. L. P. Swamy "Properties of Light Weight Aggregate Concrete with Cinder and Silicafume Admixture".

[7] Benchaa Benabed a, El-Hadj Kadri b, Lakhdar Azzouz a, Said Kenai. "Properties of self-compacting mortar made with various types of sand"

[8] Tarun R. Naik , Rakesh Kumar, Bruce W. Ramme, Fethullah Canpolat, "Development of high-strength, economical self-consolidating concrete"

AUTHORS

First Author – Mr. Sanjay raj A, Asst. Professor, REVA Institute of Technology and Management, Bangalore- 560064. Email: sanjayraja@revainstitution.org

Second Author – Yogananda N, PG Student, REVA Institute of Technology and Management, Bangalore-560064 , Email: yogananda347@gmail.com