A Study on Fresh Properties of M60 Grade Self Compacting Concrete

N Lakshmi Harika[1], P Koteswararao[2], V Bhaskar naidu[3], J Priya[4], T. S Gangadhar[5]
[1, 2, 3, 4, 5] Department of CIVIL Engineering
[1, 2, 3, 4, 5] Kakinada Institute of Technology and Science, Divili

Abstract- *Now a day's concrete plays major role in construction industry. There are many problems occurred in concrete industry such as quality, durability and reliability. These problems are mainly related to the compaction and curing. To minimize these problems required a sound concrete to withstand compaction and curing problems. In this present study, self-compacting concrete of 60MPa with a curing compounds (liquid paraffin wax light) with three dosages (0.1%, 0.5% and 1.0%) were discussed. Fresh properties- slump flow, L-box, J-ring, and V-funnel tests were done on self-compacting concrete to satisfy EFNARC specifications. Compressive strength tests were carried out on hardened concrete The compressive strength of self-cured specimens is almost nearer to conventional cured i.e., wet cured concrete. Optimum dosage of self curing agent is 1% for Liquid Paraffin Wax Light in strength point of view.*

Keywords- Cement, coarse aggregate, fine aggregate, Fly Ash, paraffin wax light, Super plasticizer, Slump flow test, U-box and L-box test, V-funnel test, Compressive strength.

I. INTRODUCTION

Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. To make durable concrete structures, sufficient compaction is required. The use of self-compacting concrete (SCC) is spreading worldwide because of its very attractive properties in the fresh state as well as after hardening. The use of SCC will lead to a more industrialized production, reduce the technical costs of in situ concrete constructions, improve the quality, durability and reliability of concrete structures and eliminate potential for human error.

1. **Self-Compacting Concrete (SCC)** is a new generation concrete, which has generated tremendous interest since its initial development in Japan by Okamura in the late1980's in order to reach durable concrete structures. SCC has gained wide use for placement in congested reinforced concrete structures with difficult casting conditions. For such applications, fresh concrete must possess high fluidity and good cohesiveness.

The advantages of SCC are

1) It eliminates noise due to vibration.
2) It provides high stability during transport and placement.
3) It provides uniform surface quality and homogenous.
4) It provides greater freedom for design
5) It is useful for casting of underwater structures.

2. Composition of SCC

SCC is a fluid mixture, le which is suitable for placing in difficult conditions and in structures with congested reinforcement, without vibration. In principle, a self-compacting or self-consolidating concrete must .

- Have a fluidity that allows self compaction without external energy.
- Remain homogeneous in a form during and after the placing process, and
- Flow easily through reinforcement.

3. Constituent Materials of SCC:

The general constituent materials of SCC are cement, aggregates, water, fly ash, super plasticizer and viscosity modifying agents.

In addition to this stone powder, mineral filler, silica fume, Nano- particles, GGBS and other admixtures.

4. Advantages of SCC

1. Heavily reinforced sections
2. Complex shapes of form works
3. Faster Construction
4. Reduction in site manpower
5. Better appearance
6. Easier Placing
7. Improved durability
8. Reduced noise levels, absence of vibration

5. Liquid paraffin wax

Liquid paraffin is a mixture of hydrocarbons. It is obtained through the petroleum distillation process. It is the clear, light fraction of the distillation process and it can be further purified. It is also known as adepsine oil, glymol, saxol and Vaseline oil.

Table 1. Physical and Chemical properties of Paraffin Wax

Sr.No	Characteristcs	Lquid Paraffin Wax
1	Specific gravity @ 25ºc	Between 0.820 to 0.860
2	Dynamic viscosity @ 20ºc	Between 25 to 80 mpas
3	Appearance	Clear colour less liquid.
4	Solubility	Passes
5	Solid Paraffins	Compiles as per standards
6	Flash point (PMCC), ºc	Min. 150 º
7	Acidity /alkalinity	Passes
8	Light absorption @ 240-280 nm	Less than 0.1
9	Readily carbon sable substances	Passes

II. LITERATURE REVIEW

To understand the fresh properties and hardening characteristics of Self Compacting Concrete, there is a need to investigate the development and mechanism behind this self compacting concrete. There is need to investigate the role of different concrete materials in this composite. The literature review presented in this chapter covers a review on SCC.

Hajime okamura A new type of concrete, which can be compacted into every corner of a formwork purely by means of its own weight, was proposed by Okamurain 1986,he started a research project on the flowing ability and workability of this special type of concrete, later called self-compacting concrete. The Self-Compactability of this concrete can be largely affected by the characteristics of materials and the mix proportions. In his study, Okamura (1997) has fixed the coarse aggregate content to50% of the solid volume and the fine aggregate content to 40% of the mortar volume, so that Self Compactability could be achieved easily by adjusting the water to cement ratio and super plasticizer dosage only. A model formwork, comprised of two vertical sections (towers) at each end of a horizontal trough, was used by professor Okamura to observe how well Self-Compacting Concrete could flow through obstacles. The concrete was placed into a right-hand tower, flowed through the obstacles, and rose in the left-hand tower. The concrete in the left-hand tower rose to almost the same level as in the right-hand tower. Similar experiments of this type were carried out over a period of about one year and the applicability of Self Compacting Concrete for practical structures was verified. With a super plasticizer the paste can be made more flowable with little concomitant decrease in viscosity. The water-cement ratio was taken between 0.4 and 0.6 depending on the properties of the cement. The super plasticizer dosage and the final water-cement ratio were determined so, as to ensure the self-Compactability, evaluated subsequently by using the U-type test, after Okamura began his research in 1986, other researchers in Japan have started to investigates Self Compacting Concrete, looking to improve its characteristics. One of those was Ozawa who has done some research independently from Okamura, and in the summer of 1988.

Nan Su proposed a simple mix design method for SCC. The amount of aggregates required is determined, and the paste of binders is then filled into the voids of aggregates to ensure that the concrete thus obtained has flow ability, self-compacting ability and other desired SCC properties. The amount of aggregates, binder, and mixing water, as well as type and dosage of super plasticizer (SP) to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, L-flow, U-box and compressive strength tests were carried out to examine the performance of SCC, and the results indicate that the proposed method could produce successfully SCC of high quality. The method involved determines Aggregate Packing Factor (PF) and influence on the strength, flow ability and self-compatibility ability.

EFNARC specifications in designing the mix, it is most useful to consider the relative proportions of the key components by volume rather than by mass. Indicative typical ranges of proportions and quantities in order to obtain self-Compactability are given below. Further modifications will be necessary to meet strength and other performance requirements.

- Water/powder ratio by volume of 0.80 to 1.10
- Total powder content - 160 to 240 liters (400-600 kg) per cubic meter.
- Coarse aggregate content normally 28 to 35 per cent by volume of the mix.
- Water/cement ratio is selected based on requirements in EN 206. Typically water content does not exceed 200 liter/m3
- The sand content balances the volume of the other constituents

III. METHODOLOGY

1. Materials used

The different materials used in this investigation are

a) Cement:

Cement used in the investigation was 53 Grade Ordinary Portland cement confirming to IS: 12269. The specific gravity of cement was 3.14 and specific surface area of 225 m2/g having initial and final setting time of 40 min and 560 min respectively.

b) Fine Aggregate:

The fine aggregate was conforming to Zone-2 according to IS: 383. The fine aggregate used was obtained from a nearby river source. The specific gravity was 2.65, while the bulk density of sand was 1.45 gram/c.c.

c) Coarse Aggregate:

Crushed granite was used as coarse aggregate. The coarse aggregate was obtained from a local crushing unit having 20mm nominal size, well graded aggregate according to IS: 383.The specific gravity was 2.8, while the bulk density was 1.5 gram/c.c.

d) Water:

Potable water was used in the experimental work for both mixing and curing companion specimens.

e) Super Plasticizer:

High range water reducing admixture confirming to ASTM C94 commonly called as super plasticizers was used for improving the flow or workability for decreased water-cement ratio without sacrifice in the compressive strength. These admixtures when they disperse in cement agglomerates significantly, decreases viscosity of the paste forming a thin film around the cement particles. In the present investigation, water-reducing admixture CHRYSO FLUID OPTIMA P-77 (poly carboxylic ether based) obtained from Chryso Chemicals, India was used. Properties of Chryso Fluid Optima P-77 are given below: Physical properties

- Form : Liquid
- Color : Transparent to slight turbid
- Specific Gravity : 1.10 + 0.02
- pH :Minimum 6.0
- Air entrainment : <1.0 % over control mixes.
- Chloride Content : Nil (As per BS: 5075)
- Water Reduction : Up to 40 % Norms & regulations CHRYSO Fluid Optima P-77 conforms to IS: 9103 and ASTM–C-494 Type G.

f) Hydrophilic Chemicals:

PEG Low molecular and high molecular weight, Liquid paraffin wax were used in the study. The chemicals were mixed with water thoroughly prior to mixing of water in concrete. The details of the physical properties of Liquid Paraffin Wax (LPW) are shown in Table-1.1

g) Liquid Paraffin Wax

Liquid paraffin is a mixture of hydrocarbons. It is obtained through the petroleum distillation process. It is the clear, light fraction of the distillation process and it can be further purified. It is also known as adepsine oil, glymol, saxol and Vaseline oil.

2. Nan SU Mix Design Procedure

The principal consideration of the proposed method is to fill the paste of binders into voids of the aggregate framework piled loosely. The loose unit weight of the aggregate is according to the shoveling procedure of ASTM C29, except discharging the aggregate at a height of 30 cm above to the top of the measure. Usually, the volume ratio of aggregate is about 52–58%, in other words, the void in the loose aggregate is about 42–48% according to ASTM C29. The strength of SCC is provided by the aggregate binding by the paste at hardened state, while the workability of SCC is provided by the binding paste at fresh state. Therefore, the contents of coarse and fine aggregates, binders, mixing water and SP will be the main factors influencing the properties of SCC. With the proposed method, all we need to do is to select the qualified materials, do the calculations, conduct mixing tests and make some adjustments, and SCC with good flowability and segregation resistance can be obtained with self-compacting ability as specified by the JSCE.

3. Basic Properties of SCC

Fresh SCC must possess at required levels the following key properties

(a) Filling ability: This is the ability of the SCC to flow into all spaces within the formwork under its own weight.
(b) Passing ability: This is the ability of the SCC to flow through tight openings such as spaces between steel reinforcing bars under its own weight.

(c) Resistance to segregation: The SCC must meet the required levels of properties (a) & (b) while its composition remains uniform throughout the process of transport and placing. Many tests have been used in successful applications of SCC. However, in all the projects the SCC was produced and placed by an experienced contractor whose staff has been trained and acquired experience with interpretation of a different group of tests. In other cases, the construction was preceded by full-scale trials in which a number, often excessive, of specific tests was used (Ouchi et al., 1996). The same tests were later used on the site itself.

IV. RESULTS AND DISCUSSIONS

Table 2. Fresh properties

S NO.	Plain SCC	Liquid Paraffin wax light			EFNARC Specifications
	0%	0.1%	0.5%	1%	
SLUMP FLOW(mm)	700	705	730	745	550-900
J-RING (mm)	7	7	7	8	0-10
L-BOX	0.88	0.89	0.9	0.92	0.8-1.0
V-FUNNEL (Sec)	7.02	7.67	8.29	8.5	6-12

V. CONCLUSION

- The optimum dosage is 1% of Liquid Paraffin Wax Light.
- The 28, 56 and 90 days compressive strength showed optimum results with 1.0% in almost all the grades of concrete
- It is also noted that at this dosage the compressive strength at 28, 56 and 90 days is either equal higher than indoor based specimens.
- The compressive strength at 28, 56 and 90 days using 1.0% of Liquid Paraffin Wax dosage for lower grade is almost equal to that obtained by conventional SCC specimens.

V. ACKNOWLEDGEMENT

The authors wish to thankEr.R.Rama Krishna garu,Er.S.Ashok Kumar garu Dr. RDayakar Babugaru, Department of Civil Engineering, and Management of KITS Engineering College for guidance and providing facilities to complete this project.

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