AN EXPERIMENTAL INVESTIGATION ON MECHANICAL OF SELF COMPACTING CONCRETE

KU. Mani Kandhan[1], T. Sri Vishnu [2]

[1]Associate Professor, Department of Civil Engineering, Nandha Engineering College, Erode.
[2]M.E Student , Department of Civil Engineering, Nandha Engineering College, Erode.

Abstract - *Concrete are the most important materials used in construction industries where the external forces more than design loads mainly the lateral forces which leads to the deformation and produce cracks in the joints of the structural member. The usage of cement has been increased more over the worlds results in the air pollution which leads to the ozone depletion. Self Compacting concrete get dense and compacted due to its own self-weight. An experimental investigation has been carried to determine the durability and mechanical properties of the Self -Compacting concrete Comparison Between EFNARC and IS Codal provision with Mix Design proportions for a particular mix of SCC. Test methods used to study the properties of fresh concrete were slump test, U- test , V- funnel and L – Box test. Compare of EFNARC and IS Standard with various Viscosity Modifying Admixtures like Glenium Stream 2,Auramix, Poly Ethylene Glycos(PEG).With various percentage of addition to make which one give better strength between them all.*

***Key Words*: Self compacting concrete, EFNARC, IS, VMA, HRWR.**

1. INTRODUCTION

Self-compacting concrete (SCC) represents one of the most outstanding advances in concrete technology during the last decade. At first developed in japan in the late 1980, SCC meanwhile is spread all over the world with steadily increasing number of application. Due to its specific properties, SCC may contribute to a significant improvement of the quality of concrete structure and open up new fields for the application of concrete. SCC describes a concrete with the ability to compact itself only by means of its own weight without requirement of vibration. It fills all recesses, reinforcement spaces and voids, even in highly reinforced concrete members and flows free of segregation nearly to level balance. While flowing in reinforcement. While using these types of concrete, several special conditions are to be followed to achieve the best the formwork, SCC is able to deaerate almost completely. The use of SCC offers many benefits to the construction practice the elimination of the compaction work results in reduced in costs of placement, a shortening of the construction time and therefore in an productivity. The application of SCC also leads to a reduction of noise during casting, better working conditions and the possibility of expanding the placing times in inner city areas. Other advantages of SCC are an improved homogeneity of the concrete production and the excellent surface quality without blowholes or other surface defects. Often the materials costs of SCC will be higher than he equivalent material costs of a normal vibrated concrete however, when SCC is sensibly utilized, the reduced of costs caused by better productivity, shorter construction time and improved working conditions will compensate the higher material costs and in many cases, may result in more favorable prizes of the final

1.1 SELF COMPACTING CONCRETE

Self Compacting concrete was first developed in japan around the year 1980. Professor H. Okamura from the university of Tokyo is mainly responsible for initiating the development of such concrete. Self Compacting concrete also referred to as Self Consolidation Concrete or silent concrete can be considered as the greatest technical advancement and most today. This is the concrete for the future. It is reported in the year 2003 approximately 50% of total concrete executed in japan is self compacting concrete. In India it was used for the first time in the year 2003 and the work was executed by Gammon India Ltd.

This type of concrete was first propose by Okamura in 1986. The motivation behind this was the gradual reduction of skilled workers in Japan's construction industry which led to a reduction in the quality of construction work. This further, affected adversely the durability of concrete that has been poorly compacted. SCC was developed to counter the problems of compaction and associated poor quality of concrete. It is basically a high flowable concrete. When the construction industry in japan experienced a decline in the availability of skilled labor in the 1980's a need was felt for a concrete that would overcome the problems of defective workmanship. This led to a development of self compacting concrete, primarily through the work of Okamura. Data indicate that the share of application of SCC, in pre cast concrete industry is more than three times than that in the ready-mixed concrete industry. This is attributed to the higher cost of SCC. The estimated average price of SCC supplied by RMC industry in japan was 1.5 times that of the conventional concrete in the year 2002, such as in lattice type structures, casting without pump, and tunnel linings.It was developed in order to overcome the following problems in conventional concrete construction:

- Improper consolidation of inaccessible of inaccessible area (deep lying or in zones of congested reinforcement) it can ensure quality.
- Tremendous waste of energy in vibration – based compaction. 21
- Vibration- related hearing loss and other injuries to workers.

2. REVIEW WORKS

- **Payal Painuly:** Making concrete structure without compaction has been done in the past. Like placement of concrete underwater by the use of termie without compaction. Inaccessible areas were concreted using such techniques. The production of such mixes often used expensive admixtures and very large quantity of cement. But such concrete was generally of lower strength and difficult to obtain. This lead to the development of Self Compacting Concrete (SCC) The workability properties of SCC such as filling ability, passing ability and segregation resistance are evaluated using workability tests such as slump flow, V-funnel and L-Box tests.
- **Mr. Anup Panusuria:** Concrete is a family of binding material, fine aggregate, coarse aggregate and water. Concrete is normally used in the frame structure. But there is some limitation like self-compaction, surface finishes, maintains strength at congested area. Due to this limitation we are trying to make self- compacting concrete with the use of mineral admixture. SCC is concrete that can be placed and compacted under its own weight without any vibration effort, assuring complete filling of formwork even when access is hindered by narrow gaps between reinforcement bars. The primary objective of this study is to make use of Ground granulated blast furnace slag (GGBS) as a replacement of cement and understand its effects on the fresh properties, compressive strength weathering. The study also intended to quantify the amount of Ground granulated blast furnace slag (GGBS) to be added to the concrete according to the value of concrete properties Measured. The workability of self-compacted concrete is increased as content of GGBS increased. Compressive strength of SCC with GGBS is increased up to 10% replacement of cement with GGBS.
- **Guru Jawahar:** This paper investigated the use of mini slump cone test along with the graduated glass plate to obtain the optimization of Superplasticizer (SP) and Viscosity Modifying Agent (VMA) in self compacting mortar (SCM). The SCM mixes had 35% replacement of cement with class F fly ash and water/cementitious ratios by weight (w/cm) 0.32 and 0.36. It is observed that for the same cementitious proportions, the optimum dosage of SP was the same for the mixes having w/cm 0.32 and 0.36. Mortar mixes with w/cm 0.36 showed an increase in the rate of flow i.e., lower viscosity at each level of SP dosage as compared to that of mixes with w/cm 0.32. It is also observed that minimum dosage of VMA was required to use in the mortar mixes having w/cm 0.36 in order to arrest the bleeding. Whereas, the use of VMA dosage was not required to use in the mortar mixes having w/cm 0.32 as no bleeding was observed at the optimum dosage of SP. Practically, it is seen that mini slump cone test is the best choice for SCM tests to evaluate the mortar spread and its viscosity (T_{20}). Also, it is seen that percentage of sand in mortar doesn't affect the optimum dosage of SP (saturation point) when the cementitious proportions are kept the same.

The main objective of this study is to determine the suitable percentage of Silica fume and Metakaolin replacement mixes and also to compare the results of two mixes.

3 MATERIAL PROPERTIES

- Cement
- M-Sand
- Coarse Aggregate
- Fly Ash
- Silica Fume
- Metakaolin
- Superplasticizer (Conplast 430)
- Viscosity Modifying Agent (Glenium stream 2)

Table 3.1 Physical properties of Fine Aggregate and Coarse Aggregate

Physical properties	Fine Aggregate	Coarse Aggregate
Bulk Density (kg/m^3)	1860	1300
Specific gravity	2.65	2.78

Table 3.2 Physical properties of powder content

Properties	OPC	Fly ash	Copper Slag
Specific gravity	3.15	2.12	3.30

4. CONCRETE MIX DESIGN

The mix proportion is an important factor to be considered to achieve SCC. The control (which had no admixture), and the various admixture (Copper Slag) with cement were mixed and casted to examine and quantify the properties of self-compacting concrete mixtures. The replacements were done at levels of 7.5%, 15%,22.5% and 30% by mass. The water/powder mass ratio (w/p) was selected as 0.40 after different trial mixes. The total powder content was varied at different value and was finally is fixed as 550 kg/m3

5 TESTS ON CONCRETE

5.1 COMPRESSIVE STRENGTH TEST

Compressive strength test is a mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The strength of concrete is found and determined by the crushing strength of 150mm x 150mm x 150mm, at an age of 7 and 28 days. The moulds and its base rigidly clamped together so as to reduce leakages during casting. The sides of the moulds and base plates were oiled before casting to prevent bonding between the moulds and concrete. The cube was then stored for 24 hours undisturbed.

$$f_c = (P/A)\ N/mm^2$$

where,

P = Load at which the specimen fails in Newton (N)

A = Area over which the load is applied in mm

F_c = Compressive stress in N/mm^2

Table 5.1 Table and Bar Chart for IS Codal Provision

		7 days	28 days
IS CODAL PROVISION	CP.SG 7.5%	34.13	50.43
	CP.SG 15%	36.24	51.24
	CP.SG 22.5%	37.12	53.43
	CP.SG 30%	40.12	55.96

Table 4.1 Designation of Specimens

MIX DESIGNATIONS	PROPORTION OF CEMENT AND COPPER SLAG
Mix 1	100% Cement
Mix 2	92.5% Cement + 7.5% Copper Slag
Mix 3	85% Cement + 15% Copper Slag
Mix 4	77.5% Cement + 22.5% Copper Slag
Mix 5	70% Cement + 30% Copper Slag

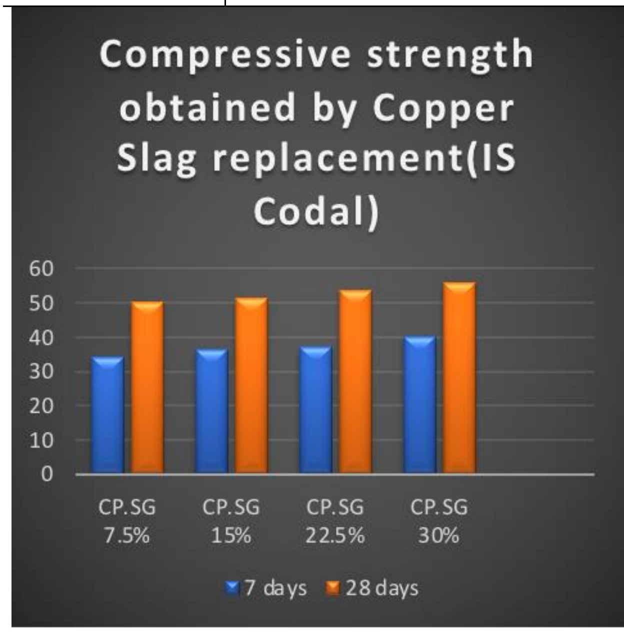
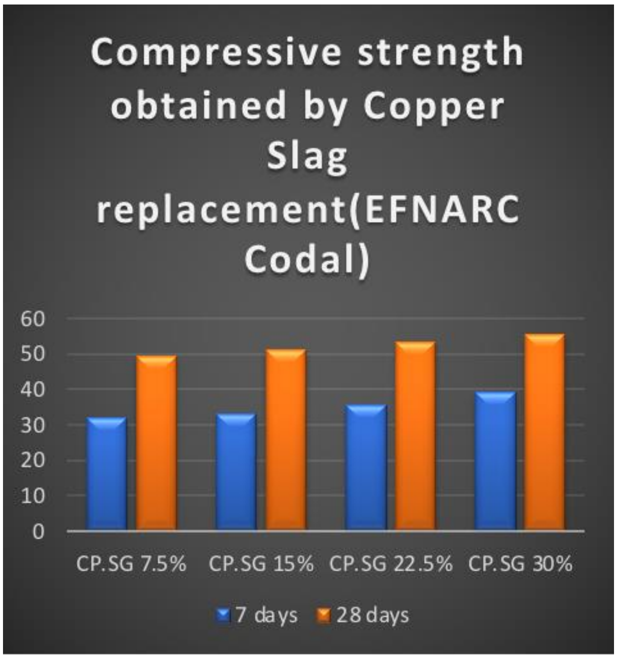


Table 5.2 Table and Bar Chart for EFNARC Codal Provision

		7 days	28 days
EFNARC CODAL PROVISION	CP.SG 7.5%	32.05	49.43
	CP.SG 15%	33.14	51.23
	CP.SG 22.5%	35.57	53.43
	CP.SG 30%	39.34	55.67



5.2 SPLIT TENSILE STRENGTH TEST

The determination of tensile strength of concrete is necessary to determine the load at which the concrete member cracks. In this test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens are tested after 7 days and 28 days. The split tension test was conducted by using digital compression machine having 2000 kN capacity.

$$f_t = 2P / \pi DL \ (N/mm^2)$$

where, P = Maximum Load (kN)

D = Diameter of Specimen (150 mm)

L = Length of Specimen (300 mm)

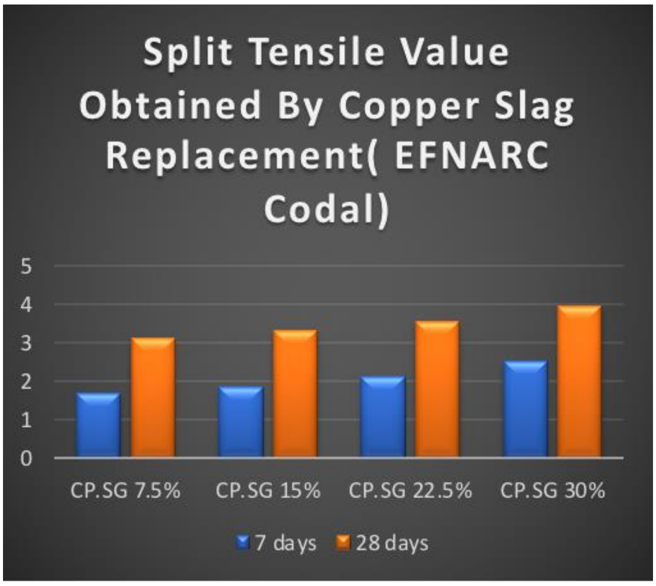
f_t = Tensile strength N/mm^2

Table 5.3 Table and Bar Chart for IS Codal Provision

		7 days	28 days
IS CODAL PROVISION	CP.SG 7.5%	1.78	3.23
	CP.SG 15%	1.83	3.45
	CP.SG 22.5%	2.01	3.67
	CP.SG 30%	2.45	4.03

Table 5.4 Table and Bar Chart for EFNARC Codal Provision

		7 days	28 days
EFNARC CODAL PROVISION	CP.SG 7.5%	1.7	3.13
	CP.SG 15%	1.85	3.33
	CP.SG 22.5%	2.11	3.56
	CP.SG 30%	2.54	3.96



3. CONCLUSIONS

I. In spite of its short history, self compacting concrete has confirmed itself as a revolutionary step forward in concrete technology.

II. Due to observed workability and high flow ability of SCC, it can be used in highly congested reinforcement structure as compare to conventional concrete.

III. Since in the near future service life design (SLD) of concrete structures will be as important as design for safety and serviceability, increased attention should be given to the role of the microstructure of the various types of available SCC's and its role for durability.

IV. Besides, from the review of literatures related to SCC which I have gone through, have got an literal facts and objectives about the SCC- Mix design based on EFNARC-2005(revised edition) and IS : 10262 – 2019(revised edition) and types of VMA based on EFNARC – 2006(revised edition).

V. So, in the forthcoming project work, I have planned to experiment the SCC in the min proportions of M_{50} Grade in EFNARC and IS codal provisions and compare their mechanical and durability proportions by casting the framed members like beams & slabs etc.,

VI. Due to its high observing factors related to workability we have to choose the VMA(EFNARC-2006 (revised edition)) based upon their reliability and their ability to flow among the concrete.

VII. Form the results of compressive strength, split tensile strength and flexural strength, the concrete shown higher value at 7.5% replacement of cement using Copper slag. So it is recommended that 30% of cement can be replaced by copper slag and in the case of Silica

VIII. Fume it is noted that the replacement by 30% gives the maximum strength.

IX. The construction industry is the only area for safe use of waste materials, which reduces cost of construction

From all the above gathered literatures and journals. we got same idea related about Self compacting concrete and learned the way of designing a self compacting concrete and way of proportion of mix design.

Above literatures and journals related with separate preparation of EFNARC and IS codal provision. It gives a results of production of self compacting concrete.

The role of the project, Study and comparison of Self compacting concrete from EFNARC and IS Provision from revised standard of EFNARC: May 2005 and IS : 2019 Edition. Comparing of Viscosity Modifying Admixtures (VMA) with this provision.

While the project completion. We can able to find which codal provision is better and suitable for making a self compacting concrete all form factors.

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