International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 6 Ver I || June 2018 || PP 69-76

Influence of Chemical admixture dosage on Fresh Properties of Self-compacting concrete

Nagaraju[1], S. Vijaya Bhaskar Reddy[2], T. Suresh[3]
[1](Assistant Professor, Civil Engineering Department, CMR Technical Campus, India)
[2] (Professor, Head of Civil Engineering Department, CMR Technical Campus, India)
[3] (Assistant Professor Civil Engineering Department, CMR Technical Campus, India)
Corresponding Auther: Nagaraju

Abstract : *The concrete is a versatile construction material because of a good compatibility existing between the ingredients of concrete. Each and every ingredient has its potency and significant effect on properties of concrete. Self-compacting concrete going to be futuristic material because of it's inherent properties like flow ability, passing ability, segregation to resistance. There are plenty of plasticizers and super plasticizers are available to make concrete to be flow able without compensating the strength. However it is very difficult to obtain the optimum dosage for making of SCC. The present paper is aiming towards study of effect of different admixtures dosage on fresh properties of Self-compacting concrete and also compressive strength of concrete. M40 mix grade of 7 mixes were made to obtain required admixture dosage. ADVA960 (Poly-carboxylic-ether based) admixture was used. Fresh properties of SCC are tested by using the slump flow test, V – flow, and L – box test. 7, 28 days of compressive strength of concrete were also tested. At Lower powder content, as admixture dosage increases, bleeding and segregation will took place. Even though dosage of admixture increases the variation in compressive strength was marginally. At 0.5% of admixture dosage, 550kgs of powder content is satisfied the all SCC requirements and reached target mean strength marginally*.

Keywords - *Self-compacting, Dosage of admixtures, fresh properties, compressive strength*

Date of Submission: 18-05-2018 Date of acceptance: 04-06-2018

I. INTRODUCTION

SCC has evolved as an innovative technology, capable of achieving the status of being an outstanding advancement in the sphere of concrete technology. Since 1824 after cement was introduced. Cement, sand, gravel and water are using in concreter mixing and vibrators were used to flow concrete. However, the construction industry in many developed countries and developing countries like Japan, india were experienced a decline in the availability of skilled labor , a need was felt for a concrete that could overcome the problems of defective workmanship. The main reasons for compacting any type of concrete are: to ensure attaining maximum density by removal of any entrapped air and to ensure that the concrete used is in full contact with both the steel reinforcement and the form work **[1]**. Therefore, this led to the development of self-compacting concrete, primarily through the work by Japan prof. Okamura **[2].**

In concrete Industry, in recent days, the researchers were more focusing on the performance rather than strength. Performance includes workability, optimum strength and durability. So many evolutions were happened in concrete to make it sustainable, one of those is Self-compacting concrete, by using Chemical admixtures (plasticizers, super plasticizers) and mineral admixtures (such as limestone powder, fly ash, micro silica, rice husk ash and blast furnace slag). The incorporation of mineral admixtures reduce the heat of hydration, provides economical benefits and also eliminates the need for viscosity-enhancing chemical admixtures. The Super plasticizer plays a major role in enhances deformability and with the water retention and reduction of water/powder, segregation resistance is increased. High deformability and high segregation resistance is obtained by limiting the amount of coarse aggregate. These two properties of mortar and concrete in turn lead to self compact ability **[3].**

SCC should have a relatively low yield value to ensure high flow ability, a moderate viscosity to resist segregation and bleeding, and must maintain its homogeneity during transportation, placing and curing to ensure adequate structural performance and long term durability. The successful development of SCC must ensure a good balance between deformability and stability **[4].**

Mechanism of Poly-carboxylic Ether (PCE) based Super-plasticizers

In general, traditional Super-plasticizers such as Melamine Sulphonate Formaldehyde condensate, which are formed by a backbone with negative functional groups attached to it, act through a mechanism of adsorption of the molecules onto the cement particles. This creates an electrostatic repulsive effect which results in the dispersion of cement particles.

The dispersion mechanism of MSF & NSF based super-plasticizers is the electrostatic repulsion between the cement particles negatively charged by the adsorption of the anionic polymer molecule onto the cement surface. The dispersion mechanism of PCE is due to the electrostatic repulsion induced due to the adsorption of the negative charge provided by the carboxylic group and steric hindrance effect from the trunk polymer (main chain)and grafted polymer chains (side chains). There is several advantages of PCE based admixtures, those are given below **[5]**.

• Significant reduction of the water demand of the mix

Short setting time

• High early strengths

• Low tendency to segregation.

The Following methods are generally adopted to know the optimum dosage of super plasticizers **[6].**

A. Marsh cone test

B. Mini slump test

C. Flow table test

There is no standard method for mix design of SCC. Many academic institutions, admixture, ready-mixed, precast and contracting companies have developed their own mix proportioning methods.

SCC offers a uniquely high flow in conventional concrete, without occurring of problems of bleeding and segregation that would normally be associated with high levels of workability. Due to its specific properties, SCC may contribute to significant improvement of the quality of concrete structures and open up new fields for the application of concrete. It can be used in repair applications, hard to reach areas, areas with congested reinforcement such as columns and walls, durable concrete, fair face concrete, pumped concrete for long distances besides all other normal concrete applications **[7].** However there are certain methods are proposed to calculate the required quantities. All these methods are developed based on the guidelines given by the EFNARC. Some of them are listed below **[3].**

1. The Japanese Method.
2. Sedran et al Method.
3. Method proposed by Gomes, Ravindra Gettu et al.
4. Nan-Su et al Method.
5. Method proposed by Jagadish Vengala.
6. European practice and specifications

II. LITERATURE REVIEW

In 1986, Due to reduction of skilled labor in Japan, Self-compacting concrete (SCC) was developed by university of Tokyo. In 1986, they completed the first structural proto type **[5]**. Later studies to develop SCC, including a fundamental study on the workability of concrete, were carried out by Ozawa and Maekawa **[8]**. In 1999, Okamura and Ozawa, have proposed a simple mixture proportioning system. In this method, the coarse and fine aggregate contents are kept constant so that self-compatibility can be achieved easily by adjusting the water/cement ratio and super plasticizer dosage only. In 1999, Petersson et al developed an alternative method for mix design including the criterion of blocking, void and paste volume as well as the test results derived from paste rheology studies. In 2002, some design guidelines have been prepared from the acceptable test methods by European federation dedicated to specialist construction chemicals and concrete systems **[6]**.

Paratibha AGGARWAL [4] et al has done an experimental study on Self-compacted concrete – procedure for mix design. They adopted japan mix design method. Initial mix design was carried out at coarse aggregate content of 50 percent by volume of concrete and fine aggregate content of 40 percent by volume of mortar in concrete, the water/powder ratio was kept at 0.90. Further, they alter the material proportion until reach the SCC. They developed SCC without using VMA.

Nanak J Pamnani [6] et al were done a comparative study on optimum dosage of different super plasticizers by marsh cone test. Basf glanium sky 784, Sika viscocrete 20he and Basf glanium B276 suretec were used as the super plasticizers. For a selected water cement ratio (0.32) the optimum dose are 1.2%, 1.3% and 1.1% for SP1, SP2 & SP3 respectively.

Nan su and buquan miao [10] were proposed a simple procedure for mix design of self-compacting concrete. In this method, packing factor determine first, then fills binding paste into voids between the aggregate to make concrete that has the desired workability and strength. It is found that the consumption of cement content will be less from this mix design.

M Mazloom and A Ranjbar [11] Were done anexperimental study on relation between the workability and strength of SCC. In other words, the main objective of this research was to find the effect of the dosages of super plasticizers on the fresh and hardened properties of the mixes. The effects of silica fume and the dosage of the super plasticizer were higher on improving the compressive strength when the w/c ratio was lower. The relation between the compressive strength and workability of concrete mixes was linear when the w/c ratio and other mix proportions were constant.

Krishna Murthy.N [12] et al were made a simple mix design procedure for self-compacting concrete. A simple and user friendly tool has been developed for SCC mix design on the basis of key proportions of the constituents of SCC with or without blended cement and with or without coarse aggregate blending.

Ali Hussein Hameed [13] was done experimental study on fresh properties of Self-compacting concrete with 5 (0.5%, 1.0%,1.5%,2.5% and 3.0%) different dosages of super plasticizers. Only the dosages 1%, 1.5% and 2.5% fulfil the all the requirement of SCC. At 0.5% dosage SCC is not formed and at 3% dosage bleeding and segregation occurred.

S. M. Dumne [14] was done a research on effect of super plasticizer on fresh and hardened properties of self-compacting concrete. The reported that, use of fly ash and chemical admixtures improved the workability, uniform and homogenous mix and strength was increasing marginally.

Dhanya Sathyan [15] et al was done an experimental Optimization of super plasticizer in port land pozzolana cement mortar and concrete. In their study 4 types of super plasticizers were used. From the marsh cone test, flow table test, and slump cone test they reported that, because of adsorption of super plasticizer on the fines crushed coarse aggregate in the Saturation dosages of super plasticizer in cement concrete is to be higher range than that of cement mortar. Optimum dosage of super plasticizer in mortar and concrete is less for PCE family of SP due to its better dispersing action contributed by steric hindrance and electrostatic repulsive force. However, good quality control is requiring to not to segregate and bleeding. Addition of SP beyond saturation dosage causes segregation of the mortar/concrete.

III. OBJECTIVE OF THE STUDY

A. The present study is aiming towards influence of super plasticizers on fresh properties of self-compacting concrete.
B. To determine the optimum dosage of super plasticizer for locally available materials.

IV. RESEARCH SIGNIFICANCE

From the review of literature, it should be noted that there is no proper mix design for SCC. The researchers were using the mix design which was available to them and reported effect of super plasticizer dosage on flow properties of SCC. In this study, the mix design was made by **IS10262:2009 and** converted to **EFNARC** guidelines and compressive strength was measured and compared with target mean strength.

V. EXPERIMENTAL INVESTIGATION

1.1 Material Used

5. 1.1Cement

In this study Ordinary Portland cement 53 grade, confirmed by **IS 12269:2013,** was used for the experimental investigation. **C**ement had 3% of fineness. Initial settling and final settling times was 35 min and 660 min. Specific gravity of cement was 3.2.

5.1.2 Fine Aggregate

In this experimental investigation, **Quarry dust** used as the fine aggregates. From the basic tests, it was confirmed Zone II, specific gravity of dust is 2.60, and water absorption was 1.2%.

5.1.3 Coarse aggregate

In this study 20mm size of crushed aggregated were used. From the basic test, specific gravity of aggregate was 2.80 and water absorption was 0.6%.

5.1.4Fly ash

In this study class-f fly ash was used.

5.2 Preparation of SCC mixes

Self-compacted Concrete (SCC) is a complex material, because of different materials involves in it and it is difficult to achieve the optimum mix design quantities. To get optimum dosage to obtain SCC several trail mixes were prepared. The tests of SCC were adopted according to time constraints and available test Equipments. In this present study to examine flow characteristics Flow table, V-funnel, and L-box tests were conducted. The mixes are made trial and error basis and obtain the required dosage. The compression test was made to know 7-days and 28 days strength.

5.3Mix Quantities

The table 3.1.1will shows the mix quantities.

Mix No	Cement	Fly ash	F.A	C.A	Water	W/C ratio (based on vol.)	Admixture dosage
Mix1	350	150	902.066	788.76	177	1	1.75
Mix2	350	150	902.066	788.76	177	1	2.5
Mix3	350	150	950.85	823.65	163.4	0.92	2
Mix4	400	150	840.85	721	188.18	1	2.2
Mix5	400	150	855.71	748.57	207.14	1	2.47
Mix6	400	150	865.71	671.42	207.14	1	2.75
Mix7	400	150	933.571	664.28	215	1.1	2.75

Table 5.3.1 Mix Quantities

5.4Test properties and methods of Evaluating SCC

Characteristic	**Test method**	**Measured value**
Flow ability/filling ability	Slump-flow	Total spread
	Kajima box	Visual filling
Viscosity/ flow ability	V-funnel	Flow time
	O-funnel	Flow time
	Orimet	Flow time
Passing ability	L-box	Passing ratio
	U-Box	Height difference
	J- ring	step height, total flow
	Kajima box	visual passing ability
Segregation resistanance	Penetration	depth
	Sieve segregation	percent laitance
	Settlement column	segregation ratio

Table 5.4.1 evaluation methods of SCC

5.5 Typical ranges of mix compositions

Constituent	Typical range by mass (kg/m3)	Typical range by volume (litres/m3)
Powder	380 - 600	
Paste		300 - 380
Water	150 - 210	150 - 210
Coarse aggregate	750 - 1000	270 - 360
Fine aggregate (sand)	Content balances the volume of the other constituents, typically 48 – 55% of total aggregate weight.	
Water/Powder ratio by Volume		0.85 – 1.10

Table 5.5.1 Mix guidelines of SCC as per EFNARC

VI. RESULTS AND DISCUSSION

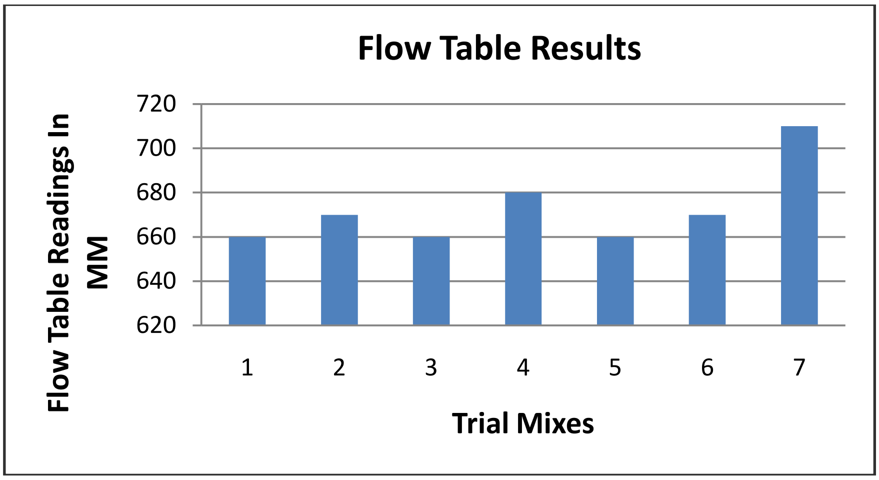
For mix 1 is made with 500Kg/m^3 of powder, 0.8 of W/c and 0.35% of admixture dosage given in unsatisfactory results. For Mix 2, all the ingredients of mix1were kept constant expect admixture dosage taken as 0.5%Mix was failed due to bleeding and segregation. For mix 3, reduced w/c ratio, 0.4%of admixture dosage was taken. This mix also failed due to bleeding and segregation, Because of in sufficient powder content. The mix 4-6, increased the powder content, taken w/c as 1 and taken 0.4%, 0.45%, 0.5%, of admixture dosages. Mix4was failed due to not satisfying the L- box and V-funnel values. For mix 7, w/c ratio was taken as 1.1 and admixture dosage was 0.5%, powder content was not changed. This mix satisfies the all requirements of SCC.

1.2 Flow table test

Fig 6.1.1: Flow table test

Trail Mix	Flow Table	Remarks
Mix-1	660 mm	Not formed
Mix-2	0 mm	Segregation
Mix-3	0mm	Segregation
Mix-4	680 mm	Not occurred
Mix-5	690 mm	obtained
Mix-6	700 mm	obtained
Mix-7	710mm	obtained

Table 6.1.1 Flow table vaules



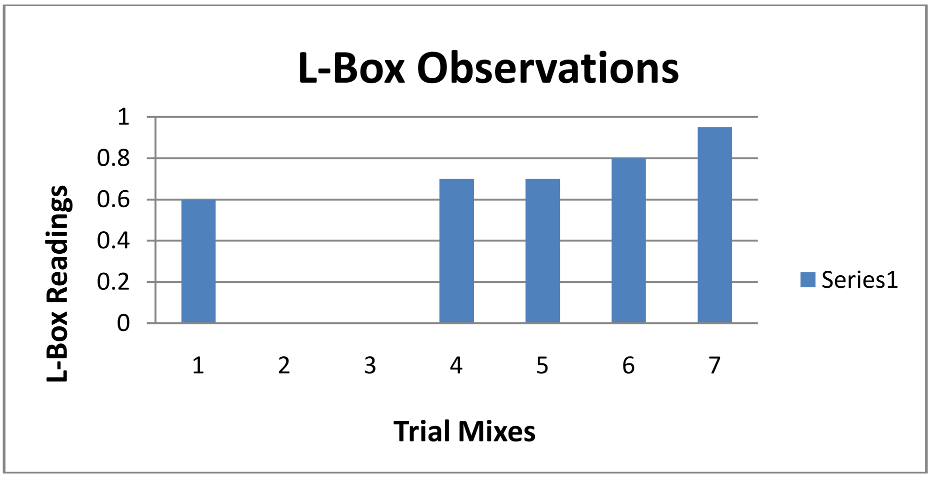
Graph 6.1.1 Flow table results

1.3 L-box test

Fig 6.2.1. L-box testing

Trail Mix	L-Box	Remarks
Mix-1	0.6	L-Box failed
Mix-2	0	Segregation Occurred
Mix-3	0	Segregation Occurred
Mix-4	0.7	L-Box failed
Mix-5	0.7	L-Box failed
Mix-6	0.8	L-Box obtained accurately
Mix-7	0.95	L-Box obtained accurately

Table 6.2.1 L-box test values

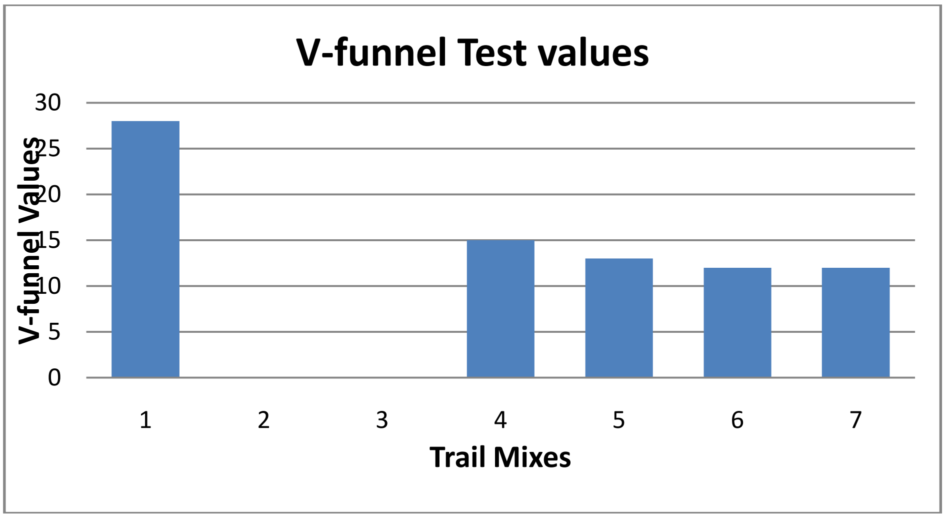


Graph 6.2.1: L-box test values

1.4 V-funnel test

Trail Mix	V-Funnel	Remarks
Mix1	28 Sec	SCC not obtained
Mix2	0 Sec	SCC not obtained
Mix3	0 Sec	SCC not obtained
Mix4	15 Sec	SCC not obtained accurately
Mix5	13 Sec	SCC obtained
Mix6	12 Sec	SCC obtained
Mix7	12 Sec	SCC obtained

Table 6.3.1 V-funnel test results

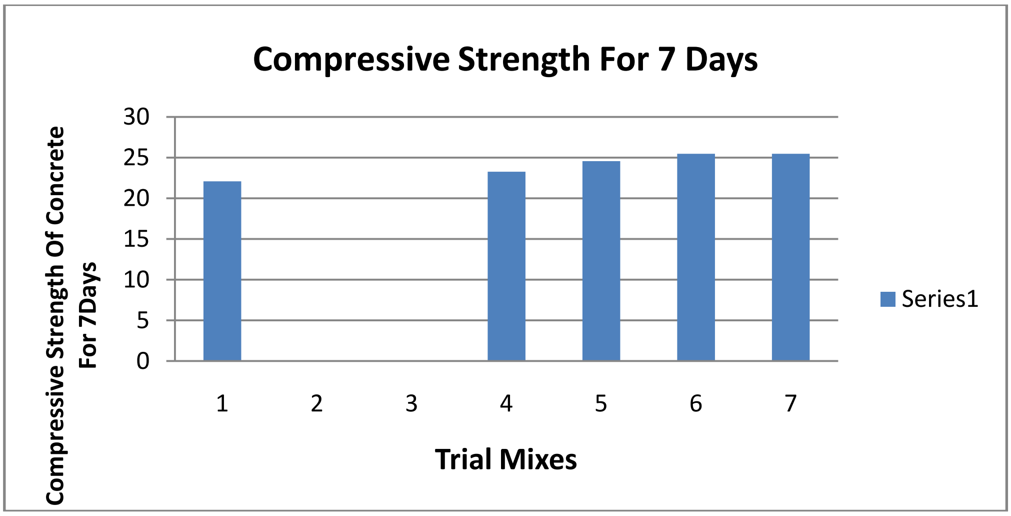


Graph 6.3.1 V-funnel test reults

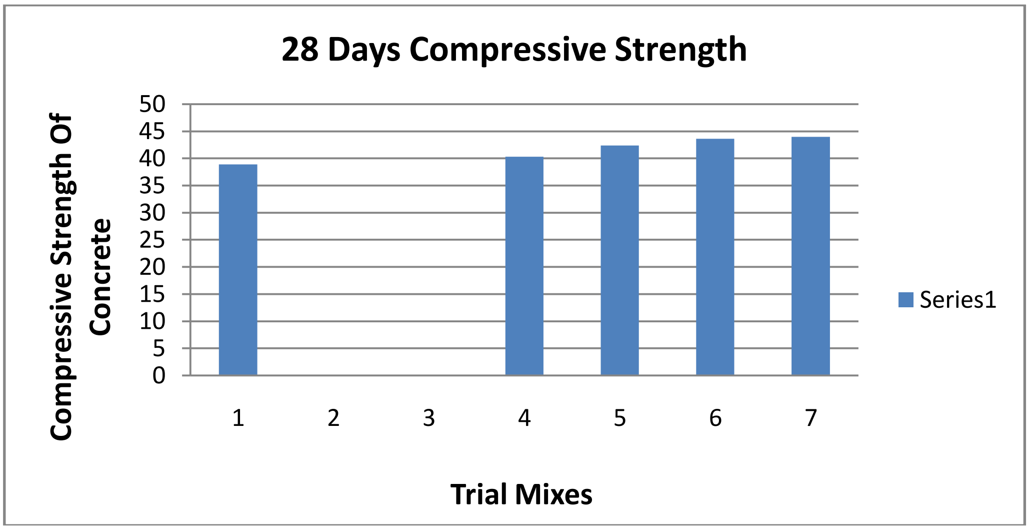
6.47-days & 28-days compressive strength

Trail mix	7-days strength	28 days strength
Mix1	22.08	38.92
Mix2	0	0
Mix3	0	0
Mix4	23.25	40.33
Mix5	24.55	42.40
Mix6	25.47	44.65
Mix7	27.35	46.25

Table 6.4.1 7-days Compressive strength values



Graph 6.4.1 7-days compressive strength values



Graph 6.4.2 28-days compressive strength

Mix1to mix 3 was not satisfy the 7-days and 28 days compressive strength. After increasing the powder content, the compreesive strength values was reached near to target mean strength. The difference between the compressive strength values 2-3%.

VII. CONCLUSIONS

To achieve optimum dosage of admixture to form self compacting concrete mainly depends up on the water powder ratio. Based on the results of present investigation, the following conclusions were drawn:

1. At lower powder content, higher water to powder ratio, higher admixture dosage leads to bleeding and segregation.
2. At lower powder content, at lower water to powder ratio, at higher admixture dosage leads to bleeding and segregation
3. At lower powder content, at higher water to powder ratio, at lower admixture dosage, the flow table test result was satisfactory however v-funnel and l-box test were failed.
4. The admixture dosage was not affected the strength of concrete.
5. At lower powder content, the compressive strength of 7 days and 28 days has not come to the near value of target mean strength.
6. At higher powder content, at lower water to powder ratio as admixture dosage increases flow table values, L-box and V-funnel values were increased. However they are not given the satisfactory results.

At higher powder content, at higher water to powder ratio, at higher dosage of admixture (0.5%) all self compacting properties were achieved and also compressive strength of 7 days and 28 days were came near to the target mean strength.

REFERENCES

[1]. Matha Prasad Adari, Prof. E.V.Raghava Rao, D.Sateesh, "An Experimental development of M40 grade self compacted concrete & camparision in behaviour with M40 conventional concrete" International Journal of Engineering Sciences & Research Technology, Volume.4, September, 2015.

[2]. Dinesh. A, Harini.S, Jasmine Jeba.P, Jincy.J, Shagufta Javed, "Experimental study on self compacting concrete", International Journal of Engineering Sciences & Research Technology, vol.6(3), March , 2017.

[3]. Hardik Upadhyay, Pankaj Shah and Elizabeth George, "Testing and Mix Design Method of Self-Compacting Concrete", National Conference on Recent Trends in Engineering & Technology, B.V.M. Engineering College, V.V.Nagar,Gujarat,, India, 13-14 May 2011.

[4]. ParatibhaAggarwal, Rafat SIDDIQUE* ,Yogesh AGGARWAL[1] , Surinder M GUPTA, "Self-Compacting Concrete - Procedure for Mix Design", Leonardo Electronic Journal of Practices and Technologies, Issue 12, January-June 2008, p. 15-24.

[5]. Binu Sukumar, Joyson Silva. P, "Effect of Polymeric Admixtures on Self-Compacting Concrete", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 1, Januray 2016.

[6]. Nanak J Pamnani, Palakkumar D. Patel, Dr. A.K. Verma, Jayeshkumar Pitroda, " Comparison and Optimization of Dosage of Different Super-Plasticizers for Self Compacted Concrete Using Marsh Cone", International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 8, February 2013.

[7]. Dr. Ghalib M. Habeeb, Dr. Mahdi S. Essa, "Effect of Water to Powder Ratio on Some Mechanical Properties of SCC", Jornal of Kerbala University, Vol. 5 No.4 Scientific, December, 2007.

[8]. Biswadeep Bharali, **"**Experimental study on self compacting concrete (ssc) using ggbs and fly ash", International Journal Of Core Engineering & Management (IJCEM) Volume 2, Issue 6, September 2015.

[9]. Rahul Dubey, Pardeep Kumar, Effect of Super Plasticizer Dosage on Compressive Strength of Self Compacting Concrete, International Journal of Civil and Structural Engineering, Volume 3, No. 2, 2012

[10]. Nan su and Buquan Maio, "A method for the mix design of medium strength flowing concrete with low cement content", cement &concrete composites 25, Elsevier, 2003, 215-222.

[11]. M Mazloom, A Ranjbar, "Relation between the workability and strength of Self-compacting Concrete", 35th Conference on our world in concrete & structures**,** 25 - 27 August 2010, Singapore.

[12]. Krishna Murthy. N, Narasimha Rao A.V, Ramana Reddy I .Vand Vijaya sekhar Reddy.M, "Mix Design Procedure for Self Compacting Concrete", IOSR Journal of Engineering, Volume 2, Issue 9 (September 2012), PP 33-41.

[13]. Ali Hussein Hamee**d, "**EFFECT OF SUPERPLASTICIZER DOSAGE ON WORKABILITY OF SELF COMPACT CONCRETE", Diyala Journal of Engineering Sciences, Vol. 05, No. 02, pp. 66-81, December, 2012.

[14]. S. M. Dumne, "Effect of Superplasticizer on Fresh and Hardened Properties of Self-Compacting Concrete Containing Fly Ash", American Journal of Engineering Research (AJER), Volume-03, Issue-03, pp-205-211, 2014.

[15]. Dhanya Sathyan , K B Anand, K M Mini and Aparna S, "Optimization of superplasticizer in portland pozzolana cement mortar and concrete", Materials Science and Engineering 310 (2018) 012036, IConAMMA-2017.

Nagaraju "Influence of Chemical admixture dosage on Fresh Properties of Self-compacting concrete "International Journal of Engineering Science Invention (IJESI), vol. 07, no. 06, 2018, pp 69-76