Comparative Study of Standard Concrete (M40 Grade) and Concrete With Super Plasticizer and Microsilica

M.Vinoth[1] , Mr.K.Kaviarasan M.E.,[2], E.Thinamani[3], V.Santhoshkumar[4],N.Bharathkumar[5]
[1, 3, 4, 5] Dept of Civil Engineering
[2]Assistant Professor, Dept of Civil Engineering
[1, 2, 3, 4, 5] Anna University Regional Campus Coimbatore

I. INTRODUCTION

Concrete mix proportioning is normally carried out by IS code method of mix proportioning for standard concrete design mix. However when any admixture/additives are proposed to be used in addition to the normal ingredients to increase the performance of concrete mix, the variables becomes more complex and it becomes more difficult to ascertain the effect of the admixture/additives.

Now-a-days due to pumping of concrete is employed at site, the workability requirement considerably more viz.125mm – 150mm slump than the normal workability of 25mm – 50mm slump, therefore it becomes necessary to use super – plasticizer. Also in pretension pre-stressed concrete members the concrete grade used is not less than M40 grade or sometime it is even more than that. And the maximum cement content in the mix should preferably not to exceed 530 kg/m^3 therefore it becomes necessary to look for some additives to increase the strength without exceeding the maximum cement content.

II. LITERATURE REVIEW

2.1 GENERAL

The use of silica fume or microsilica in combination with a superplasticizer is now a usual way to obtain high-strength concretes. The improvement of mechanical properties of concretes with silica fume accounts for the increasing consumption of this admixture in concrete. Furthermore, apart from mechanical properties, the durability of high-performance concretes concerning the most common harmful ions (sulfate, chloride, seawater) is also improved; indeed the reduction of permeability that is due to the move compact microstructure of concrete slows down the diffusion of ions.

Nevertheless, various authors point out some drawback regarding the use of silica fume in concretes. Among these, the loss of plasticity during the production of concrete and the great sensitivity of plastic shrinkage during the initial curing is the most important. However researchers seem to disagree about the interpretation of the exact role silica fume plays increase of mechanical strengths.

Some authors claim that silica fume improves the strength of the bond between the aggregates and the cement matrix. The partial replacement of cement by silica fume increases the strength of mortar and concrete; yet it does not seem to have an important impact on the strength of pure cement paste. To other researchers, however, the positive result due to the admixture of silica fume stems from the increase in strength of the cement matrix. Researchers also disagree about the definition of the optimal content of silica fume, which enables us to obtain the highest strengths. To some researchers, the content is bout 15% , whereas to others, the increase in compressive strength may reach from 30 to 40% of replacement of cement by silica fume.

In this study, we aim at defining the influence of the content of silica fume on the workability and the compressive strength of concrete. Moreover, we introduce a prediction model of the compressive strength of concrete depending on time.

PCA RESEARCH ON HIGH-STRENGTH CONCRETE," Concrete International: Design& Construction, Apr 1989, Vol. 11, No 4, pp 44-50.

This is a review of Portland Cement Association – sponsored research on high-strength, normal-weight concrete. The study was an effort to address the need for technological information about high-strength concrete applications for prestressed members, buildings, and bridges, and in situations where durability rather than strength is the primary concern. High-strength concrete for prestressed members is considered, as well as high-strength concrete for buildings. Materials development, structural design, time-dependent deformations, and fire endurance are covered. High-strength concrete for permeability and freeze-thaw resistance are also covered. Areas for future research are noted.

2.2 SUPERPLASTICIZER IN CONCRETE

Compatibility

Conplast P211 is compatible with other Fosroc admixtures in the same concrete mix. All admixtures should be added to the concrete separately and must not be premixed together rior to addition. The performance of concrete containing ore than one admixture should be assessed by trial mixes. Complast P211 is suitable for use with all types of Portland ements, SRC cements replacement materials as PFA, GGBFS and microsilica.

The use of a combination of admixtures in the same concrete mix and or cement replacements may alter the setting time. Trials should always be conducted to determine such setting times.

Dispensing

The correct quantity of Conplast P211 should be measured by means of recommended dispenser. The admixture hould then be added to the concrete with the mixing water to obtain the best results. Contact Fosroc for advice regarding suitable equipment and its installation. Estimating – packaging Conplst P211 is available in 210 litre drums or bulk supply. For larger users, storage tanks can be supplied. Storage Conplast P211 has a minimum shelf life of 12 months provided the temperature is kept within the range of 2^{o}C to 50^{o}C. Should the temperature of the produce fall outside this range then contact Fosroc for advice.

Freezing Point:

Approximately-3^{o}C Precautions

Health and safety

Conplast P211 does not fall into the hazard classifications of current regulations (see notes 1 and 2 below). However, it should not be swallowed or allowed to come into contact with skin and eyes. Suitable protective gloves and goggles should with eyes rinse immediately with plenty of water and seek medical advice. If swallowed seek medical attention immediately – do not induce vomiting. For further information consult the Materials Safety Date Sheet available for this product.

Fire

Conplast P211 is water based and non-flammable.

Cleaning and disposal

Spillages of Conplast P211 should be absorbed onto sand, earth or vermiculite and transferred to suitable containers. Remnants should be hosed down with large quantities of water.

The disposal of excess or water material should be carried out in accordance with local legislation under the guidance of the local waste regulatory authority. Additional information Conplast P211 was previously known as Complast 211.

- Provides standard water reduction at normal addition rates and significant water reduction at higher addition rates

2.3 MICROSILICA CONCRETE

Silica fume, also referred to as microsilica or condensed silica fume, is another material that is used as an artificial pozzolanic admixture. It is a product resulting from reduction of high purity quartz with coal in an electric are furnace in the manufacture of silicon or ferrosilicon alloy. Silica fume rises as an oxidized vapour. It is further processed to remove impurities and to control particle size. Condensed silica fume is essentially silicon dioxide (more than 90%) in noncrystalline form. Since it is an airborne material like fly ash, it has spherical shape. It is extremely fine with particle sixe less that average cement particles. Silica fume has specific surface area of about 20,000m^2/kg, as against 230 to 300m^2/kg

Silica fume as an admixture in concrete has opened up the advancement in concrete technology. The use of silica fume in conjunction with superplasticizer has been the backbone of modern High performance concrete.

In one article published in 1998 issue of ‘ concrete lnternational’ by Michael shydlowski President Master Builder; Inc states twenty five years ago no one in the concrete president industry could even imagine creating and placing concrete mixes that would achieve in place compressive strengths as high as 1 20mpa

The structures such as key tower in cleaveland with a design strength of 85 mpa and wacker Tower in Chicago with specified concrete strength of 85 Mpa and two union square in seattle with concrete that achieved 130 Mpa strength are testaments to the benefits of silica fume technology in concrete construction

It should be realized that silica fume by itself, do not contribute to the strength dramatically, although it does contribute to the strength property by being very fine pozzolanic material and also creating dense packing and pore filler of cement paste. Refer Fig. 5.29. Really speaking, the high strengths of high performance concrete containing silica fume are attributable, to a large degree, to the reduction in water content which becomes possible possible in the presence of high dose of superplasticizer and dense paking of cement paste.

Pierre-Claude Aitcin and adam Neville in one there papers " High- performance Concrete Demystified" states "Strengths in the range of 60 to 80 Mpa were obtained without use of silica fume. Even higher strengths up to 100 Mpa have been achieved, but only rarely. In our opinion there is no virtue in avoiding silica fume if it is available and economical, as its use

Microsilica – The choice for high performance concrete
Microsilica – The choice for high performance concrete

Silica fume (microsilica) has been called the most important new product in concrete technology in the 1990's and the material has given civil engineers another tool in the design and construction of structures for the next century.

To promote microsilica in concrete is to promote high quality concrete technology and the benefits of advanced concrete structures and sustainable high quality concrete construction.

Bridge construction, marine structures, parking structures, water supply and sewage facilities all benefit from the use of microsilica (silica fume). Likewise, the special properties of microsilica concrete give benefits in fresh concrete pumping and stability of the concrete mix. Special concretes like high strength concrete, lightweight concrete (LWC, LWAC),shotcrete and low permeability concretes are better made with microsilica.

3.3 ADVANTAGES OF MICROSILICA

Microsilica was used to achieve high compressive and tensile strength, durability, low permeability and improved properties of fresh concrete. It may be noted that microsilica was used for the first time in India.

Microsilica – a mineral composed of ultra fine solid, amorphous glassy spheres of silicon dioxide SiO_2 – is produced during the manufacturing of silicon and ferro – silicon. It contains 85-95% amorphous SiO_2 in the form of microscopic spherical particles. The average particle size of microsilica is 0.1 to 0.2 micron, which is similar to tobacco smoke and nearly 100 times smaller than that of a cement grain. Specific surface of microsilica is 15-30 sq.m/gm. Large surface area and high content of amorphous silicon dioxide gives microsilica super pozzolanic properties.

Microsilica improves the strength of concrete by two mechanisms, viz.,

As a super pozzolama.

As a filler.

Microsilica had to be imported from Norway as it is available in India Microsilica is an ultra fine material of low bulk density, which makes it difficult to handle, store and transport. Therefore, it is processed and supplied in densified form. This agglomeration of microsilica formed by densification breaks down mixing.

III. EXPERIMENTAL INVESTIGATIONS

3.4 MATERIALS

3.4.1 Cement

An OPC 53 grade was used. It was conforming to IS 12269, 1987. The properties of cement test results are follows:

TEST CERTIFICATE

5.3 GRADE ORDINARY PORTLAND CEMENT
BIRLA SUPER

PHYSICAL ANALYSIS			
Tests	Requirements of I.S. 12269-1987		
Fineness: Secific surface	303m^2 /kg	Should not be less than	225m^2 /kg
Soundness: Expansion of unaerated cement a) By Le-chateliermould b) By autoclave	0.50mm 0.0936%	Should not exceed Should not exceed	10mm 0.8%
Setting time: a) Initial set b) Finial set	130mts. 195mts.	Should not be less than Should not exceed	30mts 600mts
Compressive Strength: a) 3 days b) 7 days c) 28 days Temperature during testing Standard consitency	42.3Mpa 51.6Mpa 71.3Mpa 27^{0}C 29.7%	Should not be less than Should not be less than Should not be les Should be	27Mpa 37Mpa 53Mpa 27^{0}C±2^{0}C

CHEMICAL ANALYSIS			
Particulars: Lime saturation factor (L.S.F) Alumina iron ratio Loss on ignition (LOI) Insoluble residue (L.R) Sulphuric anhydride (SO_3) Magnesia (MgO) Alkalies Chlorides	0.92 1.16 1.29% 0.84% 2.03% 1.16% 0.46% 0.0162%	Should not be less than Should not be less than Should not exceed Should not exceed Should not exceed Should not exceed Should not exceed Should not exceed	0.80and not exceed 1.02 0.66 4% 2% 3% 6% 0.6% 0.05%

3.4.2 FINE AGGREGATE

It is the aggregate most o which passes through a 4.75mm IS sieve and contains only that much coarser material as is permitted by the specifications. Sand is generally considered to have a lower size limit of about 0.07mm. According to size, the fine aggregate may be described as coarse, medium, and fine sands. Depending upon the particle size distribution IS: 383-1970 has divided the fine aggregate into four grading zones. The grading zones become progressively finer from grating zone I to grading Zone IV.

We are using medium sand and grading zone III. The fine aggregate is used for these project study is locally available river sand. The properties as shown below as sieve analysis. By conducting sieve analysis, it is found that sand conforms to grading Zone-III as per table of IS 383-1970

FINENESS MODULUS OF FINE AGGREGATE

Sample taken = 3000 grams

SL.No.	I.S Sieve Size	Wt. Of fine Aggregate retained in each sieve (in gms)	Cumulative wt.Of fine aggregate retained in each sieve (in gms)	Cumulative % of fine aggregate retained	Percentage of fine aggregate passing
1	10mm	18.00	18.0	0.60	99.40
2	4.75mm	246.60	264.60	8.82	91.18
3	2.36mm	110.40	375.00	12.50	87.50
4	1.16mm	261.00	636.00	21.20	78.80
5	600micron	534.30	1170.30	39.01	60.99
6	300micron	1290.60	2460.00	82.03	17.97
7	150micron	536.10	2997.00	99.90	0.10
8	Receiver	3.00	3000	-	-
	Total	300		263.24	

Fineness modulus of fine aggregate = 263.24/100

= 2.63

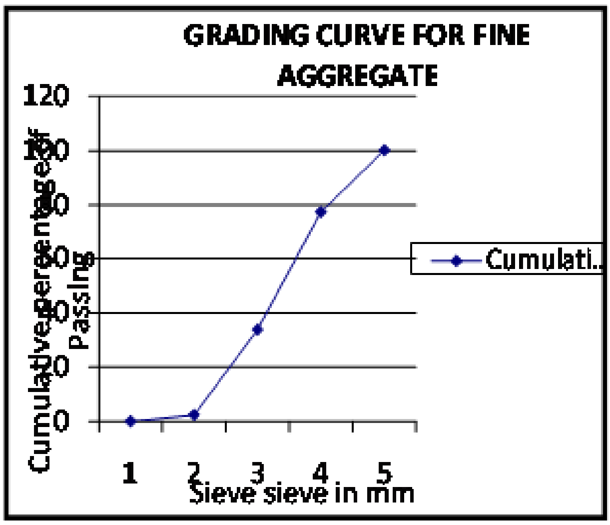
3.4.3 COARSE AGGREGATE

The aggregates most of which are retained on the 4.75mm IS sieve and contain only that much of fine material as is permitted by the specifications are termed coarse aggregates. The coarse aggregate with a maximum size of 20mm was used in this study. By conducting sieve is conforming as per IS 383-1970. The grading curve of coarse aggregate is shown in the chart.

SIEVE ANALYSIS OF COARSE AGGREGATE

Sample taken = 3000 grams

I.S. Sieve size	Wt. of fine aggregate retained in each sieve (gms)	Cumulative wt. Of coarse retained in each in sieve (in gms)	Cumulative percentage of coarse aggregate retained	Cumulative Percentage of aggregate passing
20mm	0	0	0	100
12.5mm	683.40	683.40	22.78	77.22
10mm	1301.40	1984.80	66.16	33.84
4.75mm	944	2928.80	97.63	0
2.36mm	71.20	3000	100	0



3.4.4 WATER

We are using the water for mixing and curing and it is free from harmful impurities. The water used for the mixing and curing of concrete should be free from injuries amounts of deleterious materials. The unwanted situations, leading to the distress of concrete, have been found to be a result of, among others, the mixing and curing water being of appropriate quality. Portable water is generally considered satisfactory for mixing concrete.

3.4.5 SUPERPLASTICIZER

***CONSTRUCTIVE SOLUTIONS* CONPLAST P211**

Water reducing admixture

The superplasticizer (P211) is brought from FOSROC constructive solutions at combatore. Standards compliance Conplast P211 Conforms with BS 5075 Part 1 and with ASTM C499 as Tupe A. Conplast P211 complies with the requirements of the United Kingdom Water Fittings Byelaws Scheme and is listed in the Directory of Materials as suitable for use in contact with potable water under its previous name of Conplast 211. Description Conplast P211 is a Chloride free water – reducing admixture based on selected sugar –reduced lignosulphonates. It is supplied as a brown solution, which instantly disperses in water. Conplast P211 disperses the fine particles in the concrete mix, enabling the water content of the concrete to perform more effectively and improving the consistency of the concrete. This produces higher levels of workability for the same water content, allowing benefits such as water reduction and increased strengths to be taken. Technical support Fosroc provides a technical advisory service for on-site assistances and advice on mix design, admixture selection, evolutions trials and dispensing equipment. Dosage Theoptimum dosage of Conplast P211 to meet specific requirements should always be determined by trials using the materials and conditions that will be experienced in use.

Standards compliance Conplast P211 conforms with BS 5075 Part 1 and with ASTM C494 as Type A. Conplast P211 complies with the requirements of the United kingdom Water Fittings Byelaws Scheme a and is listed in the Direcotry of Materials as suitable for use in contact with potable water under its previous name of Conplast 211. Description Conplast P211 is a chloride free wate-reducing admixture based on selected sugar-reduced lignosulphonates. It is supplied as a brown solution, which instantly disperses in water. Conplast P211 disperses the fine particles in the concrete mix, enabling the water content of the concrete to perform more effectively and improving the consistency of the concrete. This produces higher levels of workability for the same water content, allowing benefits such as water reduction and increased strengths to be taken. Tehnical support Fosroc provides a technical advisiory service for on-site assistance and advice on mix design, admixture selection, evaluation trials and dispensing equipment. Dosage Theoptium dosage of Conplast P211 to meet specific requirements should always be determined by trials using the material and conditions that will be experienced in use.

The normal dosage range is 0.4to 1.0 litres /100 kg of cementatious material, including PFA, GGBFS andmicrosilica.

Use at other dosages

Dosage outside the normal ranges quoted above can be used to meet particular mix requirements. Contact Fosroc for advice in these case.

Effects of overdosing

An overdose of double the intended amount of Conplast P211 will result in an increase in retardation as compared to that normally obtained at the intended dosage. Provided that adequate curing is maintained, the ultimate strength of the concrete will not be impaired by increased retardation and will generally be increased. The effects of overdosing will be further increased if sulphates resisting cement or cement replacement materials are used.

The dosage of superplasticizer in the concrete mix is 0.15lit. Per 50kg of cement,

The properties of Superplasticizer (conplast P211) are

Appearance	Brown liquid
Specific gravity	Typically 1.165 at 20^{0}C
Chloride content	Nil to BS 5075
Air entrainment	Typically less than 2% additional air Is entrained at normal dosages.
Alkali content	Typically less than 5.0 g. Na_2O Equivalent / litre if admixture. A fact Sheet on this subject is available.

3.4.6 MICROSILICA

Micro Silica was obtained from in production of ferrosilicon industries. It is broght from ELKEM INDIA (P) LTD, Mumbai. Conforming to ASTMC-1240 standard.

Microsilica is added with the concrete mix is 2% of cement. The characteristics of micro silica are shown in table

SiO_2 (silica die oxide, Amophous)	Mini. 85%
H_2O (Moisture)	Max 1.0% (when packed)
C (Carbon)	Max. 2.5%
LOI (Loss in Ignition)	Max.4.0%
Bulk Density (D) Kg /m^2	600-700 (when packed)

4.1 COMPERSSIVE STRENGTH TEST

The compressive test was conducted on hardened concrete; the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The cube specimen is of the size 150 x 150 x 150mm

IV. OBSERVATION

- The workability of the standard concrete M_{40} grade design mix is observed as 30mm slump and its average compressive strength of the sample at 28 days curing is obtained as 40.44 N/mm^2
- The above standard concrete M_{40} grade design mix along with 0.15 litres of superplasticizers per bag of cement (3ml of superplasticizer per kg of cement) had a workability of 140mm slump and also its average compressive strength at 28 days curing is obtained as 44.44 N/mm^2
- When the mineral additive of microsilica at 2% of the cement along with the superplasticizers had workability of 145mm slump and its average compressive strength at 28 days curing is obtained as 51.44 N/mm^2

V. CONCLUSION

Due to the addition of FOSROC P211 at the dosage 0.15litres of superplasticizer per 50kg bag of cement there is atleast an increased workability of 110mm slump than the normal workability without superplasticizer without reduction of the compressive strength.

Due to the addition of microsilica at 2% of cement along with the superplasticizer the workability of 115mm slump than the normal workability with 25% increase in the compressive strength.

Therefore whenever high workability are required we may add the superplasticizer as per recommended dosage.

Also when higher strength along with the higher workability are required we may add the microsilica and superplasicizer as per recommended dosage.

REFERENCES

[1] **A.R.SANTHAKUMAR** – Oxford university printing, concrete technology 2007
[2] **A.M.NEVILLE AND J.J. BOOKS** – CONCRETE TECHNOLOGY
[3] **A.M.NEVILLE –** PROPERTIES OF CONCRETE 2003
[4] **M.S. SHETTY –** CONCRETE TECHNOLOGY 2007
[5] **M.L.GAMBHIR –** CONCRETE TECHNOLGY 2007
[6] **IS 456 –2000** CODE FOR CONCRETE PRACTICE