Studying of Effect The High Range, Water-Reducer/ Super plasticizer, Retarding admixture on Properties of Concrete

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Abstract— Due to high temperatures in Iraq, especially in the summer, concrete pouring need to be under certain circumstances, where concrete need to addition some additives to increase the workability and delay the initial setting time.In recent decades, tremendous success has been achieved in the advancement of chemical admixtures for Portland cement. Most efforts have concentrated on improving the properties of concrete and studying the factors that influence on these properties. Since the compressive strength is considered a valuable property and is invariably a vital element of the structural design, especially high early strength development which can be provide more benefits in concrete production, such as reducing construction time and labor and saving the formwork and energy. The effect of superplasticizer and retarding properties of fresh and hardened concrete has studied; the properties of concrete such as slump, compressive strength and water absorption under normally curing concrete, hence, an experimental investigation conducted to determine the optimum dosage for the admixture and to study the effect of over dosage of the mentioned admixture, together with one control mixed. The difference between concrete mixes comes from dosage of admixture, which used at amounts 500,1000,1500 and 2000 ml/ 100 kg of cement were prepared. The test results revealed that effect of admixture on properties of concrete are dependent upon it dosage.

Index Terms— chemical admixtures, initial setting time, superplasticizer, workability.

1 INTRODUCTION

THE practical use of concrete as a construction material depends upon the fact that it is plastic in the freshly mixed state and subsequently becomes hard, with considerable strength. This change in its physical properties is due to the chemical reaction between cement and water, a process known as hydration. Hydration involves chemical changes, not just a drying out of the material, hydration is irreversible. The reaction is gradual, first causing stiffening of concrete, and then development of strength, which continues for a very long time. Under certain ideal conditions it is probable that concrete would continue to increase in strength indefinitely [1].

An admixture, according to the ASTM C-125-97a standards, is a material other than water, aggregates or hydraulic cement that is used as an ingredient of concrete or mortar, and is added to the batch immediately before or during mixing. A material such as a grinding aid added to cement during its manufacture is termed an additive [2], [3],[4].When water is added to cement, paste is formed which gradually stiffens and then hardens. The stiffening of cement paste is called setting. Basically, setting is a process of transformation from an initial state, a scattered concentrated suspension, to a final state, a connected and strengthened system of particles. This transformation in the practice of cement and concrete is obtained by chemical reactions between cement particles and water (i.e., cement hydration). Normal setting of cement is associated with the hydration of Alite (impure C3S) and formation of the calcium silicate hydrate (CSH) phase [5].

While concreting in hot weather, both setting time and compressive strength are adversely affected. To prevent concrete from the adverse effects of hot weather, admixtures are usually incorporated in it. A retarding admixture holds back the hydration process, leaving more water for workability and allowing sufficient time for the concrete to be placed, compacted and finished. Superplasticiser (SP) is used to increase the workability without changing the water/ cement ratio. Or, it can be used to increase the ultimate strength of concrete by reducing water content while maintaining adequate workability [6].

Retarding admixtures are used to delay the rate of setting of concrete. High temperatures of fresh concrete (30°C) are often the cause of an increased rate of hardening that makes placing and finishing difficult such as an exposed aggregate surface [3],[4]. One of the most practical methods of counteracting this effect is to reduce the temperature of the concrete by cooling the mixing water and/or the aggregates. Retarders do not decrease the initial temperature of concrete. The bleeding rate and bleeding capacity of concrete is increased with retarders [3]. Retarding admixtures are useful in attempts to decrease slump loss and extend workability, especially prior to placement at elevated temperatures. Retarding admixtures are also useful when difficult or unusual conditions of placement occur, such as placing concrete in large piers and foundations, cementing oil wells, or pumping grout or concrete over considerable distances [4].

PROPERTIES OF FRESH CONCRETE

Workability

Workability is defined as "the ease with which concrete can be deformed by an applied stress. The obtainable deformation depends "on the volume fraction of the aggregate and the viscosity of the cement paste". It is measured by means of the "slump test." Even though many researchers, have proposed different methods to measure the workability of flowing concrete, including flow table, the slump test remains widely in use. The slump test is a semi-static test that fails to measure the properties of flowing concrete under dynamic conditions.

Workability of concrete is affected by many factors including initial slump, type and amount of cement, temperature, relative humidity, mixing criteria (total mixing time, type of mixer, and mixer speed), as well as the presence of chemical and mineral admixtures.

Setting Time

Setting time is determined in terms of initial set and final set. These are arbitrary points between initial water-cement contact and the beginning of strength gain. Initial set is the point in time when the cement paste starts to stiffen considerably. Beyond this point, further mixing of the concrete is harmful. Final set on the other hand, is the point in time when the concrete starts to gain strength. Initial set usually occurs within 2 to 4 hours, while final set takes 5 to 8 hours after initial water-cement contact. The Vicat needle test is used for measuring setting times. The primary purpose of determining setting time is for quality control.

Slump

The rate of slump loss is greatly increased under hot weather concreting resulting in a reduction in the time during which concrete can be transported, handled and placed. Additional water is often added at the jobsite to compensate for such a high slump loss. This results in a weaker and less durable concrete, with a higher water cement ratio. The maximum allowed concrete temperature is usually set at 85 to 90 °F (29 to 32°C) depending on the type of application. Extremely high temperatures have detrimental effects on the properties of fresh and hardened concrete [7].

PROPERTIES OF HARDENED CONCRETE

Compressive Strength

Compressive strength is mainly affected by the water/ cement ratio of the concrete mixture. Strength decreases as the w /c ratio increases. Other factors affecting compressive strength include: age of the concrete, cement type and content, aggregate type, and mineral and chemical admixtures. The ultimate strength of concrete depends on the rate and degree of hydration of the cement. Higher rate of hydration results in higher early strength, but lower ultimate strength. A "more complete" degree of hydration however, results stronger and denser concrete at later age [7].

OBJECTIVE OF STUDY

The basic objective of this present research is to study the influence of :-

1- Investigate the effects of superplasticizer and retarding on properties of concrete.
2- Determine the optimum dosage for admixture.

TABLE 1
OXIDES, COMPOUND COMPOSITION AND PHYSICAL PROPERTIES OF CEMENT

Oxides	%	I.Q.S. No. 5/1984	property		Result	I.Q.S. No. 5/1984
SiO_2	20,58	–	Setting time, hrs:min	Initial set.	1:55	>00:45
Al_2O_3	3,92	–		Final set.	3:10	≤10:00
Fe_2O_3	4,00	–	Compressive strength, Mpa	3-day	27.2	≥15:00
Cao	60,78					
So_3	2,13	≤2.5		7-day	29.8	≥23:00
C_3S	52,83	–	Fineness% remain on sieve no.170(0.09 mm)		4%	≤10%
C_2S	19,23	–				
C_3A	3,63	–				
C_4AF	12,16	–				

EXPERIMENTAL INVESTIGATIONS AND SPECIFICATIONS PROPERTIES OF MATERIALS

Cement: One type of Portland cement; ordinary Portland cement (OPC) was applied. Total percentages for its oxides, compound composition and some properties were fulfilled to the requirement of Iraqi specifications No. 5/ 1984 [8]as denoted in Table 1.

Aggregate: The fine aggregate used was local sand, while the coarse aggregate used crushed gravel with maximum size 19 mm.

All their met the requirements of Iraqi specifications No. 45/ 1984 [9]with respect the sieve analysis and chemical properties as denoted in Table 2, 3, 4 and 5.

Water: Normal tap water was used as mixing water.

TABLE 3
CHEMICAL PROPERTIES OF SAND

Chemical properties	Test result	I.Q.S. No. 5/1984
So_3%	0.46%	≤ 0.5%
Cl - %	0.07%	≤0.1%

TABLE 4
SIEVE ANALYSIS OF GRAVEL

Sieve size(mm)	Cumulative % passing	I.Q.S. No. 45/1984
37	100	100
20	99	95-100
10	50	30-60
5	0.6	0-10
0.075	0.2	0-3

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TABLE 5
CHEMICAL PROPERTIES OF GRAVEL

Chemical properties	Test result	I.Q.S. No. 5/1984
So_3%	0.08%	≤ 0.1%
Cl^-%	0.07%	≤0.1%

Admixture: Synthetic based superplasticizer with a retarding effect was used. Its commercial known as ISOPLAS SP- 530 (ISOLA) . ISOPLAS SP- 530 is a high range, water-reducer/

TABLE 6
TECHNICAL DESCRIPTION OF ISOPLAS SP- 530

Appearance	Liquid
Colour	Brown
Chloride content	Nil
Compatibility with cement	All types of Portland cement
Shelf life	Twelve months
Dosage	0.5 liter to 1.5 liter per 100 kg cement

super plasticizer, retarding admixture for concrete that meets requirements of specification ASTM C494 type G [10] according to manufacture certificate. Table 6 shown the technical description for it.

CONCRETE MIXES PROPORTION

Fresh Tests

Control mixes (reference) designed for 28-days characteristic strength of 30 MPa according to ACI 211.1-95 [11] . In the laboratory experiment, the applied five concrete mixes were selected to cover the effect of the dosage of admixtures on properties of produced concrete with normally water cured (0, 0.5, 1, 1.5 and 2)% by weight of cement. All mixes were designed to have fixed proportions of total cement content of 410 kg/m^3 , sand 730 kg/m^3, gravel 1040 kg/m^3 and 190 free water content. After mixing the materials, the following fresh tests were determined for each concrete mix;

-Initial setting time according to ASTM C403-99[12].

-Slump according to ASTM C143-98 [13].

-Fresh density according to ASTM C138-2000 [14].

Hardened Tests

The following hardened concrete tests were determined for each concrete mix:

-Compressive strength

Compressive strength test involve the manufacture of test specimens which were square in shape measuring 150mm according to B.S.I 1881 part 116: 1989 [15]. The specimens were tested at age of 1, 7 and 28 days strength of the concrete under normally water curing.

-Water absorption

The water absorption test was performed according to ASTM C 642-97 [16] and carried out on 150mm cube specimens at age 28-days under normally curing. In this test, the specimens were weighted before and after immersion in water. Water absorption was then determined as the difference in the weight of specimen before and after immersion in water relative to the weight of specimen before immersion in water, expressed in percentage.

RESULTS AND DISCUSSION

a- Results of fresh tests

The results of the tested summarize in tables 7,8 and 9. The measured properties were initial setting time, slump and fresh

TABLE 2
SIEVE ANALYSIS OF SAND

Sieve size(mm)	Cumulative % passing	I.Q.S. No. 45/1984
10	100	100
4.75	98	90-100
2.36	92	85-100
1.18	81	75-100
0.6	62	60-79
0.3	14	12-40
0.15	3	0-10
0.075	2	0-5

density. The measured values for initial setting time, slump and fresh density indicate that the control mix has the lowest value when compared it with their corresponding mixes that containing of SP. The value of initial setting time, slump and fresh density for different dosages of SP plotted as a graphics shown in the Figures 1, 2 and 3 respectively.

The reduction of initial setting time for control mix M0 compared to M1, M2, M3 and M4 were 39.53%, 69.35%, 79% and 83,44% respectively. From Fig. 1, it is clear that initial setting time increases by increasing dosages.

The reduction slump for control mix M0 compared to M1, M2, M3 and M4 were 34%, 53.52%, 63.74% and 67.65% respectively. From Fig. 2, it is clear that slump increases by increasing dosages. However the SP will help to retain the concrete in liquid state for a longer time. In addition, over dosage of these

TABLE 8
RESULTS OF SLUMP

No. of Mix	SP%	slump(mm)
M0	0	66
M1	0.5	100
M2	1	142
M3	1.5	182
M4	2	204

admixtures will lead to high slump, which will not give true

TABLE 9

RESULTS OF FRESH DENSITY

No. of Mix	SP%	Fresh density kg/m^3
M0	0	2362
M1	0.5	2412
M2	1	2430
M3	1.5	2449
M4	2	2515

slump that we expect and desire.

The reduction fresh density for control mix M0 compared to M1, M2, M3 and M4 were 2.07%, 2.79%, 3.55% and 6.08% respectively.

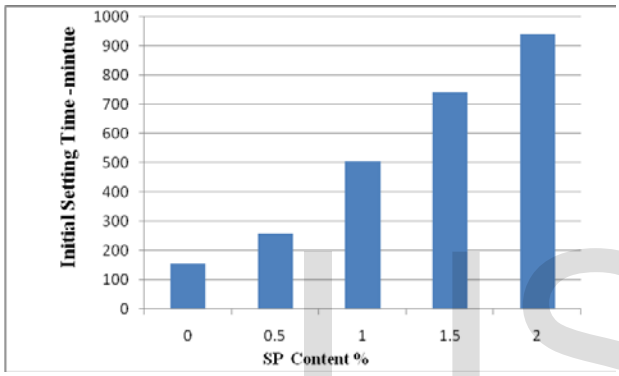

Fig. 1. Initial setting time for mixes at different SP dosages

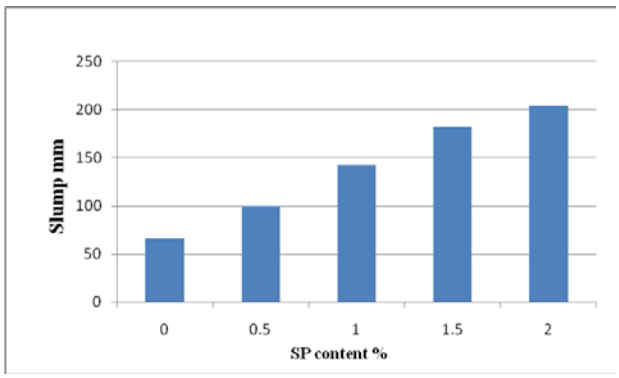

Fig. 2. Slump of mixes at different SP dosages

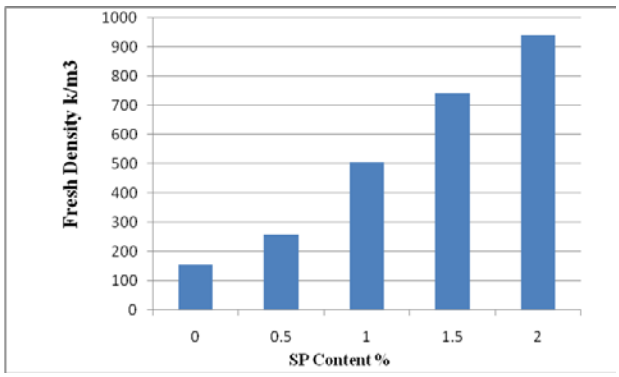

Fig. 3. Fresh density of mixes at different SP dosages

b- Results of hardened concrete tests

The results of the tested summarize in tables 10. The measured properties were compressive strength and water absorption tests. The results showed that all the concrete mixes with presences SP admixture exhibited improvement in compressive strength and noticeable reduction in water absorption compared to their control mixes. Since addition of SP will provide more water for concrete mixing, not only the hydration process will not be disturbed, but, it is accelerated by the additional water from defloration of cement particles. Hence, increase in dosage will increase the entrapped water and promote hydration of cement. The values of compressive strength for the different dosage of SP admixture for 1, 7 and 28 days are then shown as a graph in Fig. 4.

The increase ratio in compressive strength for M1, M2 and M3 mixes compared to M0 control mix were 2.18%, 6.31% and 10.91% respectively. The effect of over dosage of these admixture will lead to reduction in compressive strength. Optimum dosage of SP is found based on highest ultimate strength that present at age 28 days is 1500 ml/ 100kg of cement. Dosage with lower or higher than this optimum value will reduce the compressive strength. The reduction in water absorption at 28-

TABLE 10

Results of Compressive strength and Absorption

No. of Mix	SP %	Compressive strength MPa			Absorption %
		1-day	7-day	28-day	28-day
M0	0	10.49	21.6	32.45	1.28
M1	0.5	10.61	22.48	33.16	1.19
M2	1	10.77	24.24	34.5	1.01
M3	1.5	11.02	25.56	35.99	0.82
M4	2	10.88	23.69	32.1	0.66

RESULTS OF INITIAL SETTING TIME

No. of Mix	SP%	Initial setting time hr:min
M0	0	2:36
M1	0.5	4:18
M2	1	7:89
M3	1.5	12:23
M4	2	15:42

days in normally curing for M1, M2, M3 and M4 mixes compared to M0 control mix were 7.03 %, 21.09%, 35.93% and 48.43% respectively.

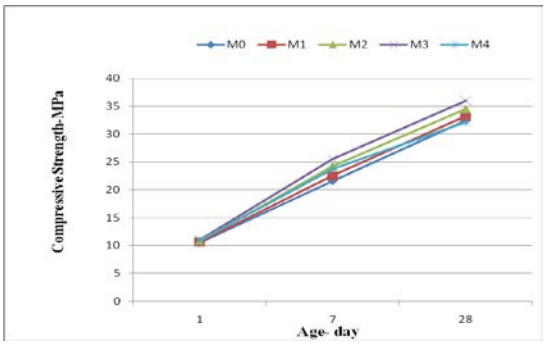

Fig. 4. Compressive Strength of mixes at different SP dosages

CONCLUSION

This paper was conducted to study the effect of superplasticizer on properties of concrete with characteristic strength of 30 MPa. The properties of fresh and hardened concrete has studied; the properties of concrete such as slump, compressive strength and water absorption under normally curing concrete. The following conclusions have been reached in this study:

1- The measured values for initial setting time, slump and fresh density indicate that the control mix has the lowest value when compared it with their corresponding mixes that containing of SP.

2- From the results of this study the workability of concrete can be increased by addition of superplasticizer. However, very high dosages of SP tend to impair the cohesiveness of concrete.

3- The results showed that all the concrete mixes with presences SP admixture exhibited improvement in compressive strength and noticeable reduction in water absorption compared to their control mixes.

4- The effect of over dosage of these admixture will lead to reduce the compressive strength.

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