International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 5 May 2022, pp: 2515-2521 www.ijaem.net ISSN: 2395-5252

A Study of Fresh and Hardened Normal Concrete Properties by Using Proposed Admixture as Superplasticizer

[1]Mohd Baseer Uddin Ahmed, [2]Mohammed Abdul Saroor , [3]Abdul Rahman, Mr. Mohd Furkhan[4]

[1,2,3]B.E Students, Dept of Civil Engineering, ISL Engineering College, Hyderabad
[4]Assistant Professor, Dept of Civil Engineering, ISL Engineering College, Hyderabad

Submitted: 20-05-2022 Revised: 28-05-2022 Accepted: 30-05-2022

ABSTRACT: Ready-mixed concrete is made in a mixing plant and brought to the construction site when it is still soft and hasn't hardened. Many chemical admixtures are used in the making of ready-mixed concrete for both technical and economic reasons. Ready-mixed concrete can have many problems, such as segregation and slump loss, if it is mixed too much or put down too slowly, especially when the weather is hot. When water is added to a mixture without changing the proportions, it hurts the compressive strength. The main goal of this research is to find out how the proposed superplasticizer affects the properties of fresh and hardened concrete so that concrete can be made that is easy to work with. These admixtures aren't used very often in the concrete industry. In this study, lignosulphonates (a commercially used superplasticizer), styrene acrylic (SA), Praepagen HY (PHY), and acrylic polymer were used as admixtures (AP). The mechanical properties of fresh and hardened concrete were first measured for a control mix made of plain concrete (no additives). Then, 0.25 percent, 0.5 percent, and 0.75 percent of the weight of the cement were added as admixtures. All of the samples, with and without admixtures, were put through the slump tests, compressive strength tests, and flexure strength tests.

KEY WORDS: Ready-mixed concrete, superplasticizer, admixtures, mechanical, fresh and hardened properties of concrete.

I. INTRODUCTION

Chemical admixtures are used in modern construction because of the need for better and faster results. Superplasticizer, in particular, has a big market today because it makes concrete easier to work with, which is one of the most important things about freshly mixed concrete (Shah et. al, 2014). The addition of superplasticizers to a concrete mix is very helpful because they help spread the cement particles out evenly, making the concrete easier to work with. Superplasticizers can be added to concrete for three different reasons, or a mix of these reasons.

- To make concrete easier to work with at a given mix composition in order to make it easier to place;
- At a given cement content and workability, reduce the mixing water to lower the water-to-cement ratio (w/c) and increase strength and improve workability.
- At a given workability and strength, to reduce both water and cement in order to save cement and cut down on creep, shrinkage, and thermal strains caused by the heat of cement hydration.

Today, superplasticizers are used in all important projects around the world. They are used in tall buildings, concrete that has been pre-stressed, thin parts with densely packed reinforcement, beams, slabs, and long, thin columns. Concrete is made in a mixing plant, and it is sent to construction sites before it has hardened. There can be many problems with concrete, like segregation and slump loss, if it is mixed too much and put in place before it is hard. When water is added to fresh concrete without adjusting the proportions of the mix, it causes a lot of problems that hurt the concrete's compressive strength, segregation, honeycombing, bleeding, and shrinkage. This study looks at how lignosulphonates (a commercially available superplasticizer admixture) and styrene acrylic, Praepagen HY, and acrylic polymer, which aren't

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used very often, change the properties of fresh and hardened concrete.
The goal of this work is to find out what happens to the mechanical properties of fresh and hardened concrete when a few admixtures that aren't used very often are added.

The goals of this study are:
i. Using Styrene Acrylic, Acrylic Polymer, and Praepagen HY as proposed new admixtures (superplasticizers).
ii. Find out what effect each admixture has on the mechanical properties of fresh concrete and concrete that has already hardened.
iii. Figure out the best proportions (doses) for each type of admixture.
iv. Make the typical slump loss curve for each type of admixture.

Methodology
The following plan of action is taken:
1- Read up on how superplasticizers affect the properties of both fresh and hardened concrete.
2-Choosing the materials that will be used in the programme for testing.
3-Running a test programme to find out how each admixture affects the properties of fresh and hardened concrete.
4-Looking at the test results and making a slump loss curve for each admixture dosage.
5- Making suggestions and coming to a conclusion.

II. LITERATURE REVIEW

Admixtures are chemicals, added to concrete, mortar or grout at the time of mixing, to modify the properties, either in the wet state immediately after mixing or after the mix have hardened. They can be a single chemical or a blend of several chemicals and may be supplied as powders but most are aqueous solutions because in this form they are easier to dispense accurately into, and then disperse through the concrete.

Superplasticizers are an essential component in modern concretes, providing workability enhancement at low water to cement ratios, and resulting in the production of durable and sustainable concrete.

The main characteristics of superplasticizing admixtures are their capability to reduce the water content of a mix design. An enhanced durability is one of the consequences of the water reduction, induced by a low concrete permeability. Superplasticizers respond mainly to the current trend to use flowable concrete types. Therefore superplasticized concrete is suitable to be placed in congested reinforcement and in hard accessible areas. Concrete with a fluid consistency can be used to cast any type of structural element. Superplasticizers have also been used for tunnel linings and spray applications. One of the industries where superplasticizers are indispensable is the wet heavy precast industries, where initial compressive strengths of 40 MPa are needed after 12-18 hrs. Self-Compacting Concrete and high strength concrete (> 100MPa) are impossible to produce without the latest superplasticizing admixtures.

Alsadey presented the effect of superplasticizer (SP) on properties of fresh and hardened concrete has studied; the properties of concrete inspected are compressive strength and slump test, 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 dosages of admixture, which used at amounts 600, 800, 1000, and 1200 ml/100 kg of cement were prepared. However, compressive strength is improved by dosage 1.0 % of SP after 28 days curing is 55 N/ mm2 , which is higher than that of control concrete, the optimum amount of admixture must be 1 %. Over dosage of SP found to deteriorate the properties of concrete with indication of lower compressive strength. The workability of concrete can be increased by addition of superplasticizer and the slump loss can be reduced by using the chemical admixtures.

Hameed discussed the results of an experimental investigation into the properties of self-compacting concrete (SCC) mixes having varying dosage of high-performance superplasticizer (Glenium 51) (0.5%-3.0%) L per 100 kg of cement material. The properties investigated are workability on the fresh state of concrete by using one mix with five superplasticizer dosage (0.5%,1.0%,1.5%,2.5% and 3.0%) is used. The workability was assessed using three tests according to the specification of selfcompacted concrete (slump flow, L- box differential height and V-funnel tests. The three dosage (1.0%, 1.5% and 2.5%) comply with requirement for production of SCC while 0.5% and 3.0% don't comply with specification requirement .Dosage of superplasticizer need to produce self-compacted concrete range between (1.0%-2.5%) L/100 kg of cement according to the condition and material used in this paper.

III. EXPERIMENTAL PROGRAM

The experimental program comprises studying the effect of each admixture at several contents for obtaining the mechanical properties of

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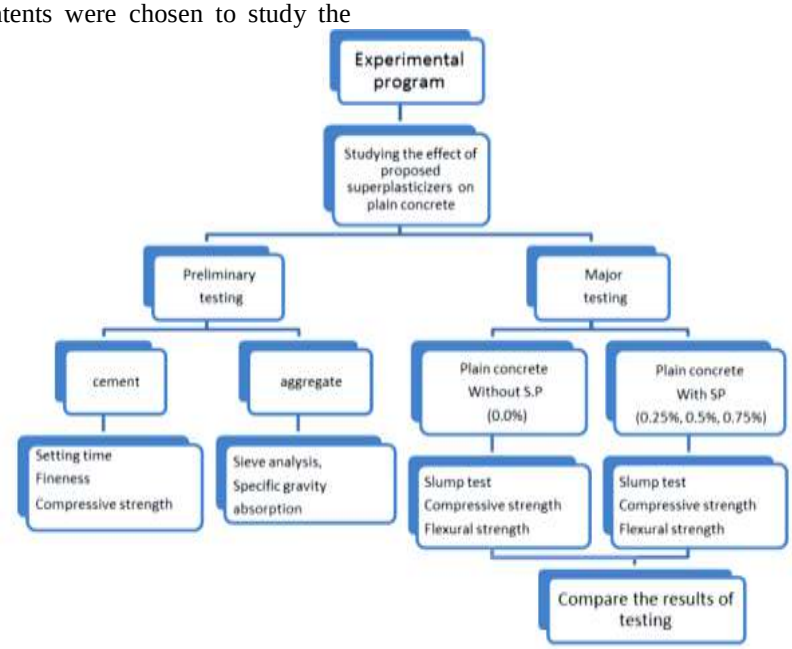
fresh and hardened concrete. Through the basic tests, the optimal contents of each material can be defined. These tests were as slump test for fresh concrete, and cubic compressive strength and flexural for hardened concrete. The admixtures that used in mix were added to the water at three contents as 0.25%, 0.5% and 0.75% by cement weight. These contents were chosen to study the amount and rate of slump loss of fresh concrete by measuring the slump value at 0, 15, 30 ... 120 minute). The compressive strength for hardened concrete of all admixture contents was tested at 7, 14 and 28 days using 10*10*10 cm cubic sample. Figure presents the details of the conducted experimental program.



Materials Used:

In this investigation cement which is of the ordinary Portland cement 53 grade, locally available river sand and coarse aggregate of good quality was used.

S. No.	Characteristics	Value obtained
1	Standard Consistency	35
2	Initial Setting Time	36 minutes
3	Final Setting Time	400 minutes
4	Specific Gravity	3.15

Table 1: Physical properties of Cement.

S. No.	Physical property	Value obtained
1	Fineness modulus	2.75
2	Grading zone	I
3	Specific Gravity	2.74
4	Moisture Content	0.5%
5	Water Absorption	1.5%

Table 2: Physical properties of Fine aggregate.

S. No.	Physical property	Value obtained
1	Fineness modulus	7.07
2	Nominal size	20 mm
3	Specific Gravity	2.65
4	Moisture Content	Nil
5	Water Absorption	0.5%

Table 3: Physical properties of Coarse aggregate.

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The quality of water is important, because impurities in it may interfere with the setting of the cement and it may adversely affect the strength of the concrete or cause staining of its surface and may also lead to corrosion of the reinforcement. Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic material they may be deleterious to concrete or steel permissible limits.

Physical and Chemical Properties Of Proposed Superplasticizer

Lignosulphonate (LS): The single largest use for lignosulphonates is as plasticizers in making concrete, where they allow concrete to be made with less water (giving stronger concrete) while maintaining the ability of the concrete to flow. Lignosulphonates are also used during the production of cement, where they act as grinding aids in the cement mill and as a raw mix slurry deflocculates (that reduces the viscosity of the slurry).

Styrene acrylic polymer (SA): Styrene Acrylic emulsions polymer use in flexible coatings, maintenance coating for metal and asphalt roofing surfaces suitable for moderate climates. SA has good adhesion to various substrates, including galvanized metal and concrete and good water resistance properties.

Praepagen HY (PHY): The Chemical characterization of Praepagen HY is an aqueous solution of an alkyl dimethyl hydroxy ethyl ammonium chloride. Praepagen HY is used as raw material for detergents.

Acrylic polymer (AP): Acrylic polymer is a small particle size and excellent response to rheology modifiers. It is resulting in coatings with excellent long-term durability. AP is noted for its excellent adhesion on wide variety of surfaces such as wood, smooth concrete surfaces, old chalky painted surfaces, etc. It also has excellent abrasion resistance, alkali resistance and UV resistance.

Mix Proportioning

By finishing of all tests for concrete constituent and ensure that all material as water, aggregate , sand and cement are according to ASTM specification, the concrete job mix with a target strength of 30 MPa at 28 day is designed. The Mix Design adopted is

Material	**Weight-(kg)**
Entrapped-air	0
Water	177
Cement	300
Coarse-aggregate	1220
Fine-aggregate	670
Total	2367

Mixing procedure

The concrete is mixed according to the Standard Method of Making and Curing Test Specimens in the Laboratory. Firstly, the coarse aggregate is added with some of the mixing water then starting rotation of the mixer. After that, fine aggregate, cement and remain mixing water are added. The SP material is added to water (mixing water). Note that the open end or top of the mixer will be covered to prevent evaporation during the rest period. A power-driven tilting revolving drum mixer is used in the mixing process.

After 24 hour, the hardened concrete removed from the molds with very carefully to prevent any defect in the samples. After that the samples placed in curing water tank at temperature 21-25 degree C until the period of testing.

IV. TESTING OF SPECIMENS

The main aim of this research is to study the effect of proposed superplasticizers on the mechanical properties of fresh and hardened concrete using component as limestone aggregate, sand, cement and superplasticizer. The following tests were applied to obtain the effects of proposed superplasticizers on the mechanical properties of fresh and hardened concrete.

Fresh concrete tests

After completing the mixing of fresh concrete there are many test can be done to measure the workability of concrete, in this research will depend on slump test to measure the workability.

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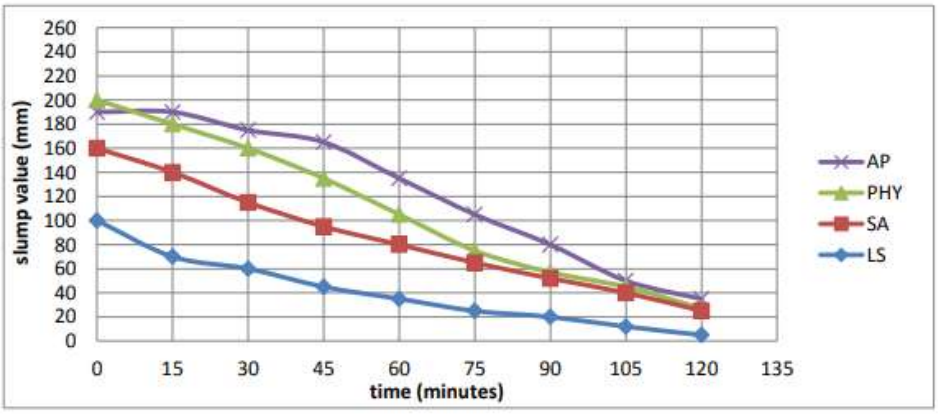
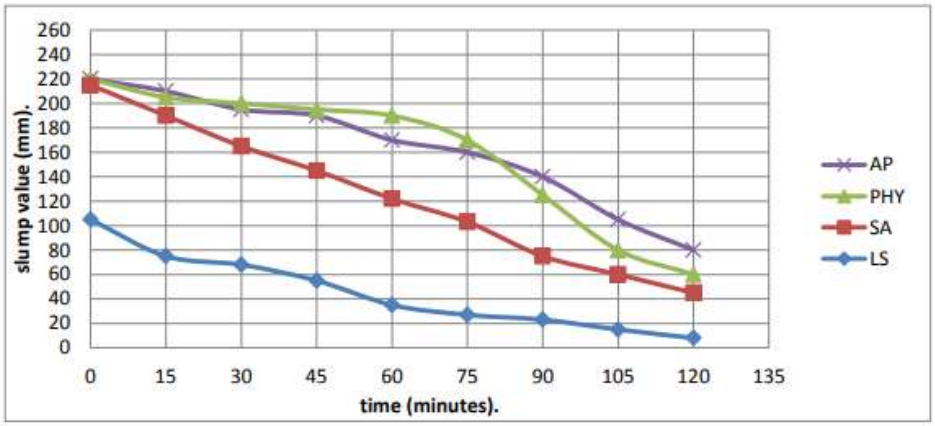
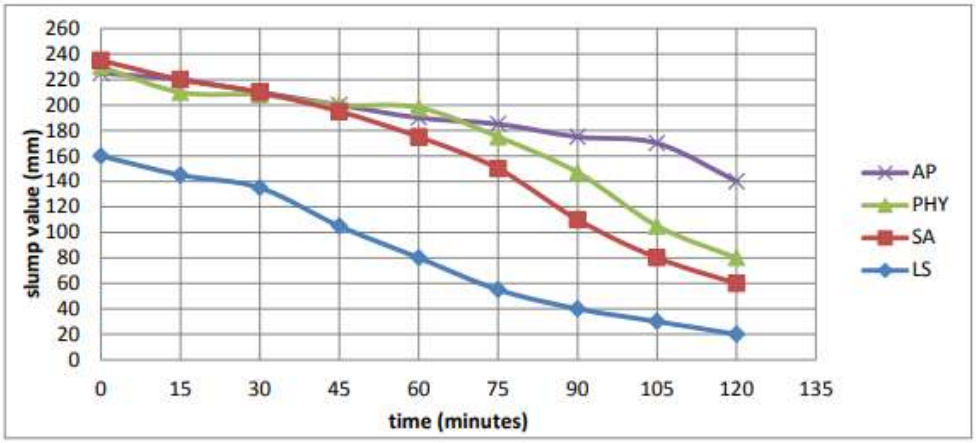


Relation between several admixtures with 0.25% ratio and slump values



Relation between several admixtures with 0.5% ratio and slump values



Relation between several admixtures with 0.75% ratio and slump values

Compressive strength test results

The 7 days and 28 days compressive strength of concrete for proposed admixtures (SA, PHY and AP admixtures) contents and commercially admixture (LS) is presented in Figures. For all used admixture the increasing dosage of admixture decreased the compressive strength as shown in the figures.

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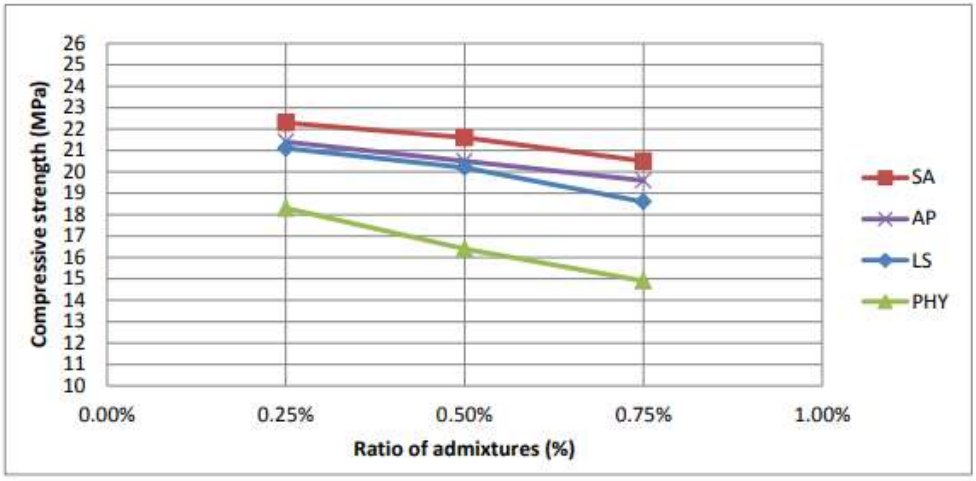
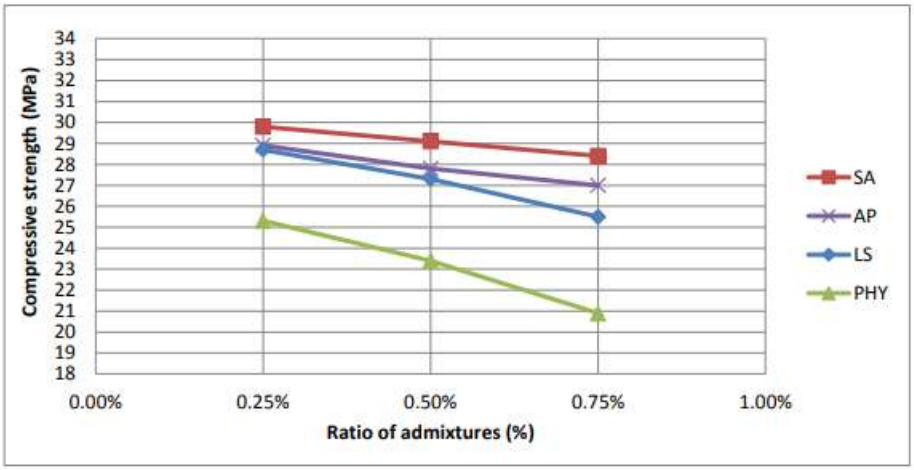


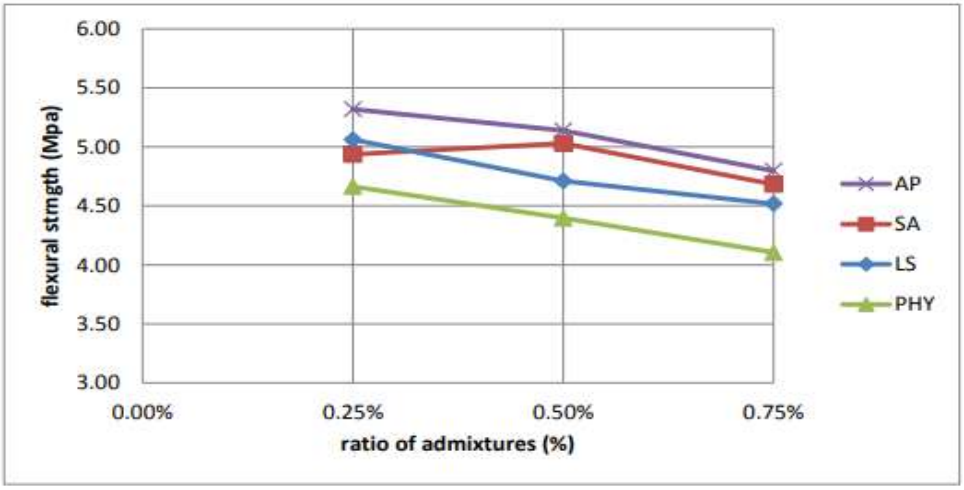
Comparison between 7 days age compressive strength for several admixtures contents



Comparison between 28 days age compressive strength for several admixtures contents

Effect of admixtures on Flexural strength

The 28 days flexural strength for each admixtures contents and the control mix which applied in this study is presented in Figure. The flexural strength of plain concrete without any admixture is measured to be 4.73 MPa.



Relation between admixtures with several ratios and flexural strength

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V. CONCLUSION

The results of this research showed that applied admixtures styrene acrylic (SA), Praepagen HY (PHY) and acrylic polymer (AP) can enhance the workability of concrete, and reduced slump loss problem, and new admixtures SA and AP can improve the compressive strength compared with LS (locally commercial admixture). The following concluding remarks were obtained from the obtained experimental observation:

All admixtures enhanced the slump, where the slump improved by using SA,PHY and AP admixtures compared with LS (commercially admixture). Admixtures show enormous increase in slump without any significant segregation. Compressive strength improved by SA and AP admixtures compared with LS (commercially admixture); while the PHY admixture affected adversely compared with LS. The slump values of plain concrete were 70 mm and 6 mm with true shape at zero and 90 minute respectively, the compressive strength of plain concrete was 21.9 MPa at 7 days age and 30.6 MPa at 28 days age.

The flexural strength of plain concrete was 4.73 MPa and the fracture was normal in the middle span.

The optimum content of LS is 0.75% by cement weight; the using of higher dosage than 0.75% does not show any significant improvement to concrete slump. At 0.75% content of LS admixture the slump value of concrete was enhanced to reach 160 mm. However the compressive strength at this content was 25.5 MPa and the flexural strength was 4.52MPa; also the fracture was normal in the middle span. The optimum content of SA is 0. 5% by cement weight; the using of higher dosage than 0.5% does not show any significant improvement to concrete slump. At 0.5% content of SA admixture the slump value of concrete was enhanced to reach 215 mm with increasing of 105% compared with LS admixture. Howeverthe compressive strength at this ratio is 29.1 MPa. The flexural strength was 5.03 MPa; also the fracture was normal in the middle span.

The optimum content of PHY is 0.5% by cement weight; the using of higher dosage than 0.5% does not show any significant improvement to concrete slump. At 0.5% content of PHY admixture the slump value of concrete was enhanced to reach 220 mm with increasing of 110% compared with LS admixture. However the compressive strength at this ratio is 23.4 MPa and the flexural strength was 4.40MPa; also the fracture was normal in the middle span. The optimum content of AP is 0.5% by cement weight; the using of higher dosage than 0.5% does not show any significant improvement to concrete slump. At 0.5% content of AP admixture the slump value of concrete was enhanced to reach 220 mm with increasing of 110 % compared with LS admixture. However the compressive strength at this ratio 27.8 MPa. The flexural strength was 5.14MPa also the fracture was normal in the middle span.

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