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Influence of Super Plasticizer and Time Lag on Compressive and Flexural Strength of High Performance Concrete

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Abstract:- **In recent decades, tremendous success was achieved in the advancement of chemical admixtures for Portland cement concrete. The effect of super plasticizer (SP) on the properties of fresh and hardened concrete like compressive and flexural strength is well documented. But the influence of the dosage of Super Plasticizer and time lag on the compressive and flexural strength of High Performance Concrete is yet to be determined. In this study, the effect of the dosage and time lag in placement of concrete is studied. Four grades of concrete: M20, M30, M40, M50 were chosen and cubes and beams were casted for different dosages of super plasticizer ranging from 0.5 to 1.1 percent of the cementitious material and for different time lags ranging from 0 to 4 hrs. Testing was carried out to assess the effect of the dosage of super plasticizer and the effect of time lag in the placement of concrete. The results of the experimental procedure carried out and the inference from the study are discussed.**

Keywords:- super plasticizer,Tim lag, Flexural Strength, compressive Strength

1.0 INTRODUCTION

Concrete is the most widely used construction material in the world. Its consumption is around 10 billion tons per year]High performance concrete is that which is designed to give optimized performance characteristics for the given set of materials, usage and exposure conditions, consistent with requirements of cost, service life and durability. Architects, engineers and constructors all over the world are finding that application of HPC allows them to build more durable structures at comparable costs. HPC is being used for buildings in aggressive environments, marine structures, highway bridges and pavements, nuclear structures, tunnels, precast units, etc. High performance concrete (HPC) has recently become very attractive to civil engineers and material scientists. As it exhibits higher workability, greater mechanical properties and better durability[1], HPC has been increasingly applied in the constructions such as tall building, bridges and off-shore structures. One important chemical admixture in preparing HPC is super plasticizer. The most important improvement

in concrete technology during the 30 last years has been the use of super plasticizers. However, the reason that super plasticizers are much more important than any other chemical admixture is the number of improvements, which can be achieved by its use. However, the reason for widespread usage of admixtures is that admixtures are able to impart considerable physical and economic benefits with respect to concrete. However, usage of admixture is not remedy for poor quality of concrete due to the use of incorrect mix proportion, poor workmanship in concrete mixing and the problems caused by low quality raw materials selection. Advances in superplasticizers[1][2], containing alternative water soluble synthetic products, have been proposed in the last decade to reduce the slump-loss drawback which can partly or completely cancel the initial technical advantage associated with the use of superplasticizers (low *w/c* ratio or high slump level). The utilization of superplasticizer will have positive effects on properties of concrete, both in the fresh and hardened states. In the fresh state, utilization of superplasticizer will normally reduce tendency to bleeding due to the reduction in water/ cement ratio or water content of concrete. However, if water/ cement ratio is maintained, there is tendency that superplasticizer will prolong the time of set of concrete as more water is available to lubricate the mix. In the case of hardened concrete, highlighted that the use of superplasticizer will increase compressive strength by enhancing the effectiveness of compaction to produce denser concrete. Risk of drying shrinkage will be reduced by retaining the concrete in liquid state for longer period of time.

In addition, rate of carbonation become slower when water/cement ratio is decreased with the presence of super plasticizer

2.0 EXPERIMENTAL PLAN

In this experiment with the selected super plasticizer the study of time- lag, workability and flexural strength of concrete are done for various grades like M20, M30, M40, and M50. For each grade we have to cast “48 beams” of various dosage of super plasticizer. Along with this we are also doing time lag of concrete for each grade This is done in the form of various sets as mentioned below in a tabular column.

Materials

The 53 grade ordinary Portland cement is used as binder material in the production of concrete mixes. The fine aggregate was natural river sand. A crushed aggregate of nominal maximum size of 20 mm was used as coarse

aggregate. Sulphonated naphthalene polymers based super plasticizer Conplast P430 is used as admixture

Mixture proportions

Concrete mixtures were designed in four groups which are M50, M40, M30 and M20, respectively and were shown in Table 1. In each group of concrete mix total of 48 beams and 48 cubes were casted for different dosages of SP-430 and different time lags.

Table 1: Mixture proportions and fresh Properties

MIX	**Proportions by Weight**
M 20	1 : 2.21 : 3.61 @ 0.50
M 30	1 : 1.96 : 3.20 @ 0.50
M 40	1 : 1.74 : 2.84 @ 0.45
M 50	1: 1.37 : 2.52 @ 0.40

Test Procedure

Total 192 beams and 192 cubes of size 100*100*500 mm and 150 mm^3 were casted in standard cast-iron moulds. The specimens after curing period of 28 days were tested on Universal Testing Machine for Compressive and Flexural Strength

Table 2: Hardened properties of M 20

	Time Lag (Hrs)	*Dosage of SP-430 (%)*	*Compressive Strength N/mm²*	*Flexural Strength N/mm²*
M20	*0*	*0.5*	*31*	*5.6*
	2		*32.67*	*5.8*
	3		*28.33*	*5.4*
	4		*26*	*5.2*
	0	*0.7*	*32*	*5.9*
	2		*33.33*	*6.4*
	3		*29.67*	*5.4*
	4		*27*	*5.2*
	0	*0.9*	*33.33*	*6*
	2		*34.67*	*6.6*
	3		*30.33*	*5.7*
	4		*29*	*5.4*
	0	*1.1*	*28.33*	*5.4*
	2		*30*	*5.7*
	3		*26*	*5.3*
	4		*24.33*	*5.1*

Table 3: Hardened properties of M 30

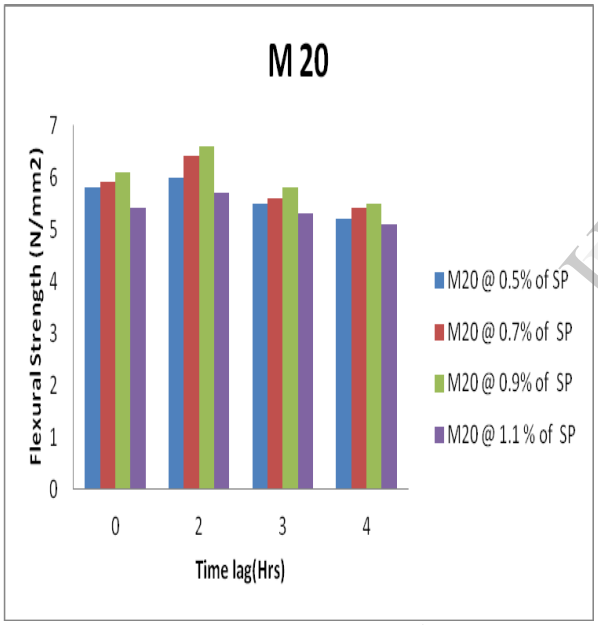
	Time Lag (Hrs)	*Dosage of SP-430 (%)*	*Compressive Strength N/mm²*	*Flexural Strength N/mm²*
M30	*0*	*0.5*	*40*	*6*
	2		*41.67*	*6.8*
	3		*37*	*6*
	4		*36.33*	*5.7*
	0	*0.7*	*41.33*	*6.4*
	2		*43*	*7.2*
	3		*39*	*6.2*
	4		*38*	*5.9*
	0	*0.9*	*43*	*6.7*
	2		*44.67*	*7.6*
	3		*41*	*6*
	4		*39.33*	*6*
	0	*1.1*	*38*	*6*
	2		*40*	*6.3*
	3		*36*	*5.6*
	4		*34.67*	*5.3*

Table 4: Hardened properties of M 40

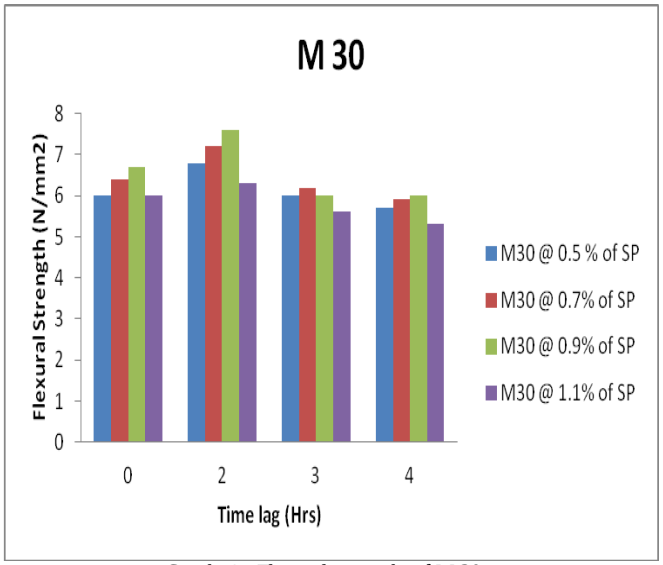
	Time Lag (Hrs)	*Dosage of SP-430 (%)*	*Compressive Strength N/mm²*	*Flexural Strength N/mm²*
M40	*0*	*0.5*	*50.33*	*6.4*
	2		*52*	*7.1*
	3		*48*	*6.1*
	4		*44.33*	*5.7*
	0	*0.7*	*52*	*6.8*
	2		*53.33*	*7.6*
	3		*50*	*6.4*
	4		*47.33*	*6.2*
	0	*0.9*	*53.33*	*7.1*
	2		*54.67*	*7.9*
	3		*52.33*	*6.8*
	4		*49.67*	*6.5*
	0	*1.1*	*48*	*6.7*
	2		*50.33*	*6.9*
	3		*46.33*	*5.9*
	4		*42.67*	*5.3*

Table 5: Hardened properties of M 50

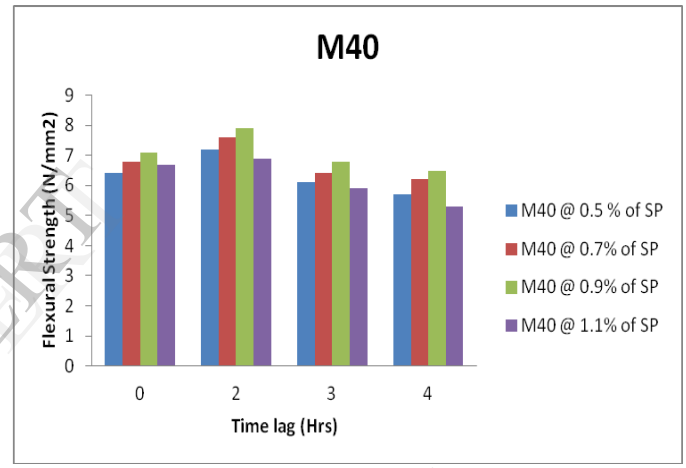
	Time Lag (Hrs)	Dosage of SP-430 (%)	Compressive Strength N/mm^2	Flexural Strength N/mm^2
M50	0	0.5	63.33	7.2
	2		65	7.7
	3		59.67	6.6
	4		56	6
	0	0.7	65	7.6
	2		67	8
	3		63.33	6.9
	4		59.67	6.3
	0	0.9	66.33	7.9
	2		68.33	8.4
	3		64.67	7.2
	4		60.33	6.6
	0	1.1	60.33	6.9
	2		62.67	7.4
	3		58.33	6.2
	4		54.67	5.7



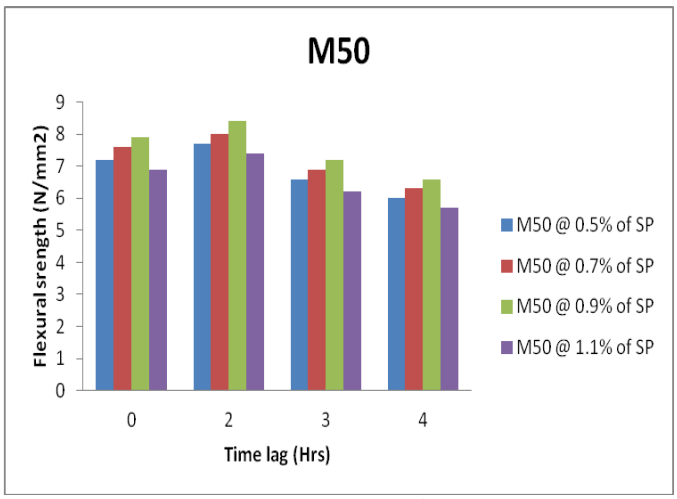
Graph: 1 Flexural strength of M 20



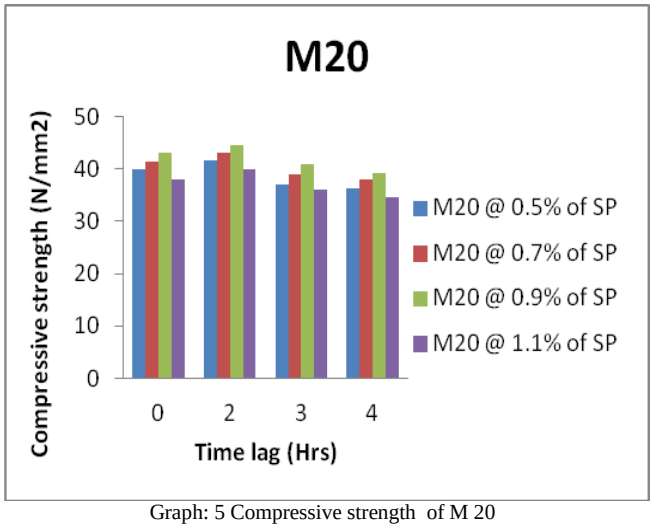
Graph: 2 Flexural strength of M 30



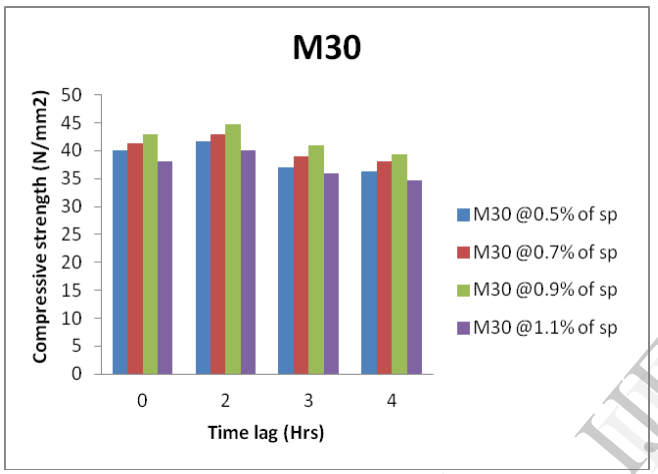
Graph: 3 Flexural strength of M 40



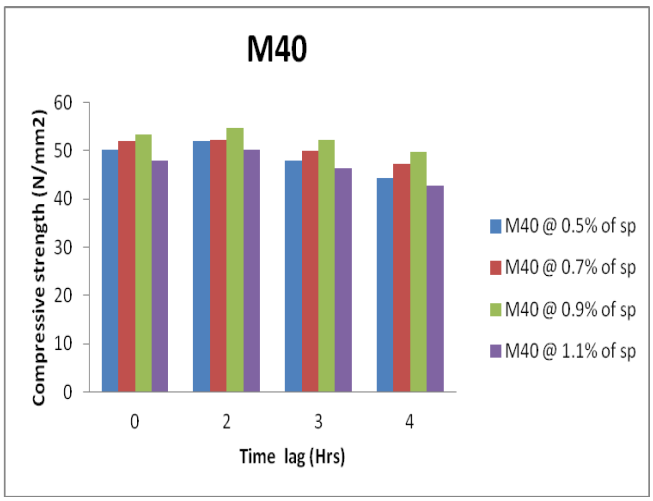
Graph: 4 Flexural strength of M 50



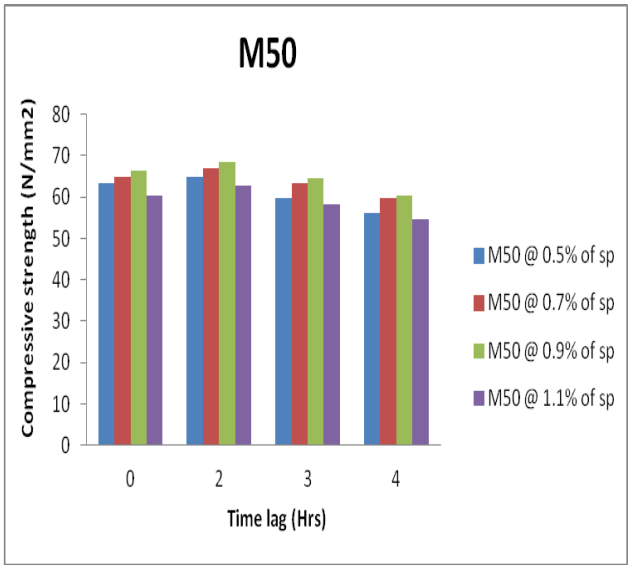
Graph: 5 Compressive strength of M 20



Graph: 6 Compressive strength of M 30



Graph: 7 Compressive strength of M 40



Graph: 8 Compressive strength of M 50

3.0 RESULTS AND DISCUSSIONS

Hardened concrete results

The hardened concrete tests like compressive strength and flexural strength were performed for all mixtures with variation in dosage of Super plasticizer (SP-430) and time lagging in placing of concrete

A1. *Compressive strength*

The compressive strength for M20, M30, M40 and M50 concrete groups respectively shown in Tables (2, 3, 4 & 5). As can be expected the compressive strength of all mixtures enhanced by the age of concrete. Among different dosages the compressive strength is optimum at 0.7 & 0.9% of dosage of SP – 430. The compressive strength is optimum at 0 and 2 hrs of time lag (delay in placing of concrete)

A2. *Flexural strength*

The same tendency as observed in compressive strength, among different dosages the flexural strength is optimum at 0.7 & 0.9% of dosage of SP – 430. The flexural strength is optimum at 0 and 2 hrs of time lag (delay in placing of concrete)

4.0 CONCLUSIONS

This study was carried out to investigate the influence of super plasticizer and time lag on workability, compressive and flexural strength of high performance concrete
The following conclusions can be drawn:

(1) It is observed that both the compressive and flexural strength of the specimens are maximum at 0 and 2 hours of time lag.

(2) It is observed that both the compressive and flexural strength of the specimens are maximum at 0.7 % and 0.9 % sp-430

(3) The increase in dosage of sp-430 more than 1 % leads to decrease in both the compressive and flexural strength of the specimens

(4) The increase in time lag more than 2 hours results in decrease of both compressive and flexural strength of the specimens

(5)The usage of super plasticizer in concrete leads to greater workability even for high strength concrete like M50.

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