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Excessive Retardation in Concrete

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***Abstract*-Setting time of concrete has vital role in the construction process. Retarders are used where early setting of concrete is not required and when higher retention period is needed to place the concrete. Chemical composition of retarder is formulated to stop the hydration temporarily to delay the initial set of concrete. Once the effect of retarder wears off initial set will begin and hardening will develop. Use of concrete as a construction material depends upon the fact that it is plastic in fresh state and gets hardens subsequently with considerable strength. This change in physical properties is due the hydration process which is irreversible. This reaction is gradual, first stiffening of concrete and then development of strength which continues for a long time. The rate of reaction primarily depends on the cement property, concrete mix, and use of mineral and chemical admixtures. It is observed from study that delayed setting of concrete has impacted only early compressive strength of concrete but later strength at 28days remains unaffected by delayed setting of concrete.**

***Keywords*- Retardation, delayed setting, admixture, setting, hardening of concrete.**

I.INTRODUCTION

Retarding admixtures are used to delay the rate of setting of concrete. High temperature of fresh concrete often cause the increased rate of hardening that makes concrete placing difficult. Retarders do not decrease the initial temperature of concrete and are useful in extending the setting time of concrete. Especially at elevated temperatures, retarders are important in maintaining the workability of concrete.

Retarders are sometimes used to 1) Offset the accelerating effect of high temperature on setting of concrete: 2) Delay the initial set of concrete.

In general, little reduction in strength at early ages is observed during usage of retarders.

Setting and hardening are controlled by C3S and C3A and thus admixtures which affect the hydration of C3S and C3A can change the hydration and subsequently setting and hardening of concrete.

II. FROSEN CLASSIFICATION OF SET CONTROLLERS

Type 1: Typically at higher dosages act as a RETARDER. Gypsum acts as a set controller at certain specified dosages only.

Type 2: Up to certain concentration setting time INCREASES and beyond that certain concentration setting time DECREASES and ACCELERATION happens. At low concentration Type II acts as a RETARDER and at higher concentration it acts as ACCELERATER.

Type 3: At low concentration Type II acts as a RETARDER and at higher concentration it acts as ACCELERATER.

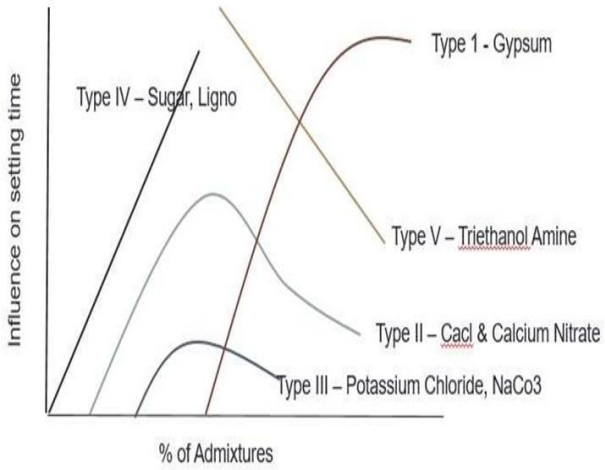

Fig 1.**Influence of different admixtures on setting time**

Type 4: Setting time INCREASES with increase of admixture concentration.

Type 5: Setting time DECREASES with increase of admixture concentration. These are constantly accelerating chemicals and thus with increase in concertation of admixture, continuous reduction in setting time of concrete is observed.

These admixtures are sometimes used in combinations to suit for the application needs.

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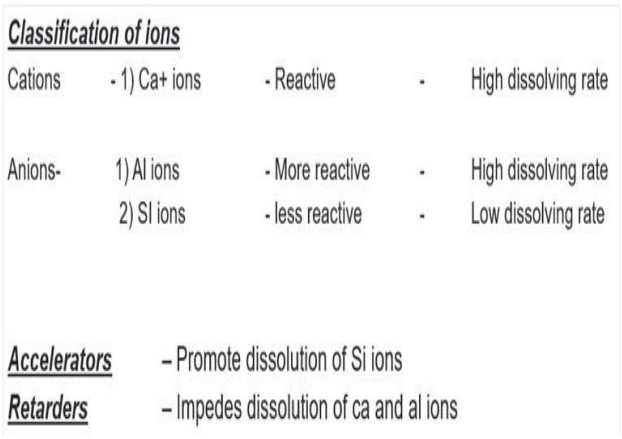
III. JOISOL CLASSIFICATION OF SET CONTROLLERS

Set Controllers either speed up or slow down the rate of dissolution of ions. Set Controllers usually affect the hydration at the early stages during dissolution process.



Retarders are one which impedes the dissolution of highly soluble or highly reactive ions and thus modifying the setting time of concrete.

Set Retardationis based on adsorption of admixture molecules on surface of cement particles which hinder further reaction between cement and water thus retarding the set.

Careful usage of retarder is required to avoid excessive retardation and rapid slump loss.

IV. TYPES OF RETARDING ADMIXTURES

1. Type B: Retarding Admixtures.
2. Type D: Water Reducing and Retarding Admixtures.

The main difference between these two is the water reducing property in Type D which helps to lower water content to achieve desired workability.

Commonly used retarders are lingo sulfonates and hydroxylated carboxylic acids. To avoid excessive retardation, TEA or formic acids are used along with this.

3. Compatibilty Issues – Indicators:
Incompatibility is the lack of expected level of performance when given combination of cement and admixture is used.

- Poor slump
- Reduced retention of concrete
- Bleeding or Segregation for longer period
- Low Early Strength
- Delayed Setting of concrete

V. TEST METHOD

Three concrete mixes were developed and in each concrete mix two trials were conducted, first trial with optimum admixture dosage and in second trial admixtures are added at higher dosage such that concrete setting is delayed. Concrete cubes of 150mm*150mm*150mm were cast and tested for compressive strength at 1day, 3day, 7day and 28days.

Setting time of concrete was calculated by plotting penetration resistance against time in graph. In this study we focused on effect of delayed setting on compressive strength of concrete.

VI. MATERIALS

1. Cement: OPC 53G cement conforming to IS 269:2015 was used.

2. Coarse Aggregates: Two type of coarse aggregates 12.5mm single sized and 20mm single sized conforming to IS 383:2016 were used.

3. Fine Aggregate: Fine aggregate used was crushed stone sand of Zone II gradation conforming to IS 383:2016.

4. Chemical Admixtures: SNF based superplasticizer is used.

Table 1. Material Properties.

Materials	Specific Gravity	Water Absorption (%)
Cement - OPC 53G	3.15	-NA-
Coarse Aggregate – 20mm	2.76	0.46 %
Coarse Aggregate – 12.5mm	2.74	0.52 %
Fine Aggregate - CSS	2.63	2.80 %
Super plasticizer	1.08	-NA-

VI. CONCRETE MIXES

Table 2.**Concrete mix proportions**

Mix reference*	OPC 53G	20 mm	12.5 mm	CSS	W/C	Super plasticizer
Mix 1 NS	410	652	429	765	0.45	0.50%
Mix 1 DS	410	652	429	765	0.45	0.80%
Mix 2 NS	320	703	463	825	0.50	0.65%
Mix 2 DS	320	703	463	825	0.50	0.90%
Mix 3 NS	450	686	543	726	0.28	0.45%
Mix 3 DS	450	686	543	726	0.28	0.70%

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*NS and DS stands for Normal setting and Delayed Setting of concrete.

VII. RESULTS & DISCUSSIONS

1. Test Results:

Compressive strength and setting time of concrete for Mix 1 NS and Mix 1 DS are given in table 1 and graph 1.

Table 3. Compressive Strength of 150mm concrete cubes.

Mix Ref	Workability	Setting Time of Concrete		Compressive Strength (N/mm2)			
		IST	FST	1 day	3 day	7 day	28 day
Mix 1 NS	Initial – Collapse 1 hr – 170mm 2 hrs – 130mm	9 hour 4 mins	10 hour53 mins	12.6	26.6	39.9	47.2
Mix 1 DS	Initial – Collapse 1 hr - Collapse 2 hr – Collapse 3 hrs – 190mm 4 hrs – 120mm	15 hour50	17 hour56	2.9	24.5	39.9	46.4

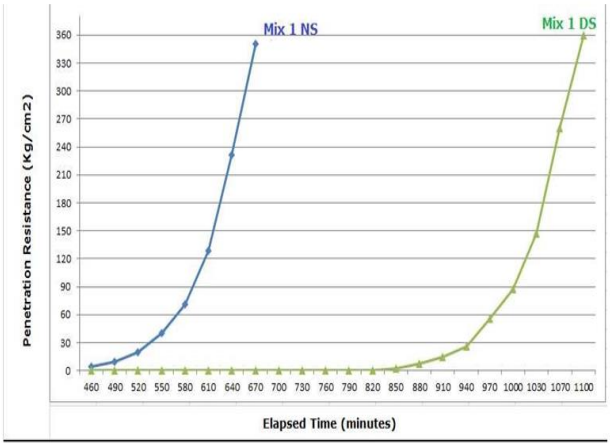

Fig 2. Graph 1: Setting time of concrete; Mix 1 NS and Mix 1DS.

2. Test Results:

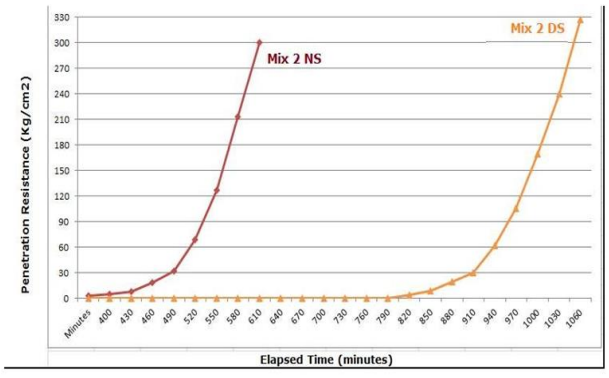

Fig 3. Graph 2: Setting time of concrete; Mix 2 NS and Mix 2 DS.

Table 4. Compressive Strength of 150mm concrete cubes.

Mix Ref	Workability	Setting Time of Concrete		Compressive Strength (N/mm2)			
		IST	FST	1 day	3 day	7 day	28 day
Mix 2 NS	Initial – Collapse 1 hr – 150mm 2 hrs – 120mm	8 hour 43 mins	10 hour 33 mins	10.0	25.5	28.6	33.2
Mix 2 DS	Initial – Collapse 1 hr - Collapse 2 hr – Collapse 3 hrs – Collapse 4 hrs – 140mm	15 hour 45 mins	17 hour54 mins	2.1	20.8	25.9	32.8

3. Test Results:

Compressive strength and setting time of concrete for Mix 3 NS and Mix 3 DS are given in table 3 and graph 1.

Table 5. Compressive Strength of 150mm concrete cubes.

Mix Ref	Workability	Setting Time of Concrete		Compressive Strength (N/mm2)			
		IST	FST	1 day	3 day	7 day	28 day
Mix 3 NS	Initial – Collapse 1 hr – 125mm	8 hour0 mins	9 hour43 mins	43.4	61.8	65.2	89.4
Mix 3 DS	Initial – Collapse 1hr – Collapse 2hr – 180mm 3hr – 160mm 4hr – 140mm	14 hour 47 mins	17 hour 33 mins	8.9	62.8	70.5	88.5

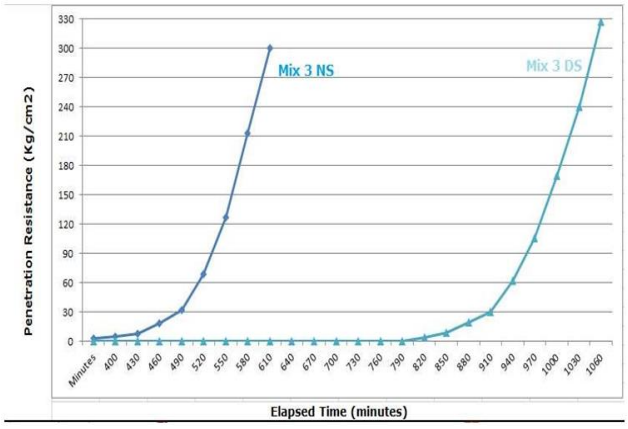

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Fig 4. Graph 2: Setting time of concrete; Mix 3 NS and Mix 3 DS.

4. Discussions:

- Setting of concrete is delayed due to higher admixture addition.
- Early strength at 1 day is affected drastically due to delayed setting.
- Later Compressive strength at 7days and 28days remains unaffected with delayed setting of concrete.
- It is evident that, due to addition of higher SNF admixture content in concrete, setting time of concrete and compressive strength at early days are affected.
- It is necessary to keep admixture content at check and periodical monitoring is necessary.
- In case of concreting time bound structures, final setting time decides the time of removal of form work.
- Higher the setting time of concrete, extended time will be required before removing form work from vertical elements.

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