EXPERIMENTAL STUDY OF STRENGTH AND DURABILITY OF CONCRETE WITH SODIUM SILICATE AS SURFACE TREATMENT WITH RESPECT TO FLY ASH

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Abstract

With the increase in demand for the performance of the material, it is essential to have binder which is reasonably priced, environmental friendly and allow better process efficiency. With respect to the same, Sodium silicate based formulations have been used for increased efficiency.

The paper presents the work carried out for the improvement of mechanical properties of fly ash by adding a binder sodium silicate. Sodium silicate is added as a binder with cement and fly ash and then compacted. .The compacts were treated in normal water at room temperature for 3 days, 7days and 28 days. The compressive strength, flexure strength were investigated.

Sodium Silicate as surface treatment is also investigated by keeping at compacts in room temperature and curing is done under special condition. Lastly beneficial for protecting from chloride attack is also investigated.

It was observed that compressive strength of fly ash increased with curing of sodium silicate and particles were dispersed and deviated from their globular equi axed shaped to multifaceted type.

Key Words: *Binder, Sodium Silicate, Fly ash, Chloride attack, equi axed shaped, multifaceted type*

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1. INTRODUCTION

The structures built across the coastal areas is less durable because of corrosion. Corrosion takes place because of the chloride ions.

The presence of the chloride ions in concrete takes place in two ways:

a) From the pure components of concrete, such as water, aggregate,and cement.
b) The intrusion of chloride ions from atmosphere.

In the case of structures that are exposed to marine environments,the chloride ions directly penetrate from the sea water or by sea salt particles,where as in non marine environments, penetration caused by winter deicing salt is the primary path. The majority of cases in which there is impact on the durability life of reinforced concrete involve chloride intrusion from the external environment. Nagtaki et al. found that the risk of chloride penetration from the outside is two or three times higher than that from internal chloride. This is due to the formation of Friedel salt that the chloride anions in cementitious composites react with monosulfate($C_3A.3CaSO_{4.}12H_2O$) and replace sulfate ions. The other reason is that, after concrete is cured, the chloride penetration from the outside is hard to resolve.

In general, measures designed to suppress corrosion due to salt damage in reinforced concrete structures can be divided into three types.

i) The use of a primary barrier by the coating of the concrete surface
ii) Barriers may be used in which the chloride ions are bound by the physical method of increasing the density of concrete itself.
iii) Barrier involving the formation of passive film itself on the surface of rebar.

In the present paper, the first two methods are adopted.

2. EXPERIMENTAL PROGRAM

The experimental program can be identified in four stages.

1. First to develop M35 grade concrete, which satisfy the properties as per IS code Specifications.
2. Second to develop M35 grade concrete with flyash (taking 30% of flyash) which satisfy the properties as per IS code specifications.
3. Third to develop M35 grade concrete with flyash by mixing sodium silicate(5% of wt.fraction) as binder .
4. Fourth to develop M35 grade concrete with flyash by adding sodium silicate as surface treatment.

To study the influence of mechanical properties such as compressive strength, cylinder test and flexural strength of concrete.

The experimental program consisted of arriving at suitable mix proportions that satisfied the IS Code specifications. Standard cubes of dimensions 150mm x 150mm x 150mm were casted to check whether the target compressive strength is achieved for 3 days, 7-days and 28-days curing. If either the fresh properties or the strength properties are not satisfied, the mix is modified accordingly. Standard cube moulds of (150x150x150mm) made of cast iron were used for casting standard cubes. The standards moulds were fitted such that there are no gaps between the plates of the moulds. If there small gaps they were fitted with plaster of paris. The moulds then oiled and kept ready for casting. Once the casting is kept for 24 hours, the specimens are demoulded and immersed in curing tank for requisite period.

Materials Used

The different materials used in this work are

- 53 Grade Ultra Tech ordinary Portland Cement
- Fine Aggregate
- Coarse Aggregat
- Fly ash
- Anhydrous Sodium silicate
- Water

This program consists of casting and testing of total 108 specimens. The specimens of standard cubes (150mm x 150mm x 150mm), standard cylinders of (150mm dia x 300mm height) and standard prisms of (150mm x 150mm x 700mm) were casted for3, 7 and 28 days for compressive strength, cylinder test and flexural strength of concrete. Additional 3 cubes were used for carbonation test.

The following preliminary tests were conducted

- Sieve analysis of coarse aggregate and fine aggregate
- Specific gravity of coarse aggregate, fine aggregate and cement
- Bulk density of coarse aggregate and fine aggregate

Mix design proportions

2.1 Preliminary Test

Preliminary test	Result
Sieve analysis of CA	F.M=7.17
Sieve analysis of FA	F.M=2.42
Specific gravity of CA	2.71
Specific gravity of FA	2.56
Water Absorption of CA	0.40
Water Absorption of FA	1.52
Bulk density of CA	1.55 kg/ltr
Bulk density of FA	1.61 kg/ltr
Percentage of Voids of CA	48.35
Percentage of Voids of FA	42.02

Concrete Mix Design

Consolidated Report

Trial No	Quantity of Cement	W/C Ratio	Quantity of Water	Mix Design proportion	Result
1	400	0.4	160	1:1.93:2.77	Not satisfactory
2	400	0.41	164	1:1.92:2.76	Not satisfactory
3	400	0.42	168	1:1.91:2.74	Not satisfactory
4	400	0.43	172	1:1.90:2.73	Not satisfactory
5	400	0.44	176	1:1.89:2.71	Not satisfactory
6	380	0.45	171	1:2.02:2.90	Not satisfactory
7	**380**	**0.44**	**167.2**	**1:1.98:2.84**	Satisfactory

Mix design with Fly ash

Ratio of Mix Proportion :1: 1.65:2.68

Result:True Slump Achieved

Mix design with Fly ash and Sodium Silicate

Ratio of Mix Proportion :1: 1.65:2.68

Result:True Slump Achieved

Consolidated Report

Cubical Test

Number of Days	M35	M35+ Flyash	M35+Flyash+ SodiumSilicate	M35+Flyash+ SodiumSilicate Curing
3	28.85	17.17	7.36	16.55
7	40.49	23.76	12.50	26.6
28	53.88	34.48	18.50	38.0

Cylinder Test

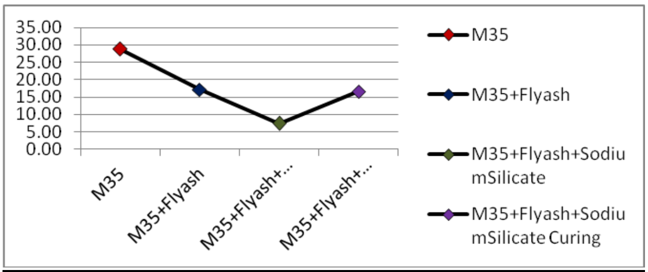
Number of Days	M35	M35+ Flyash	M35+Flyash+ SodiumSilicate	M35+Flyash+ SodiumSilicate Curing
3	16.08	8.91	4.13	9.30
7	17.17	17.17	6.34	17.58
28	25.00	21.45	8.49	34.20

Flexure Test

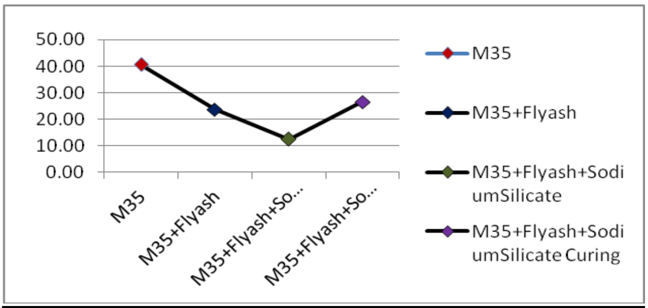
Number of Days	M35	M35+ Flyash	M35+Flyash+ SodiumSilicate	M35+Flyash+ SodiumSilicate Curing
3	1.24	0.56	0.53	0.71
7	1.49	1.22	0.78	1.23
28	1.68	1.63	1.60	1.73

Graphical Representation of Compressive Strength

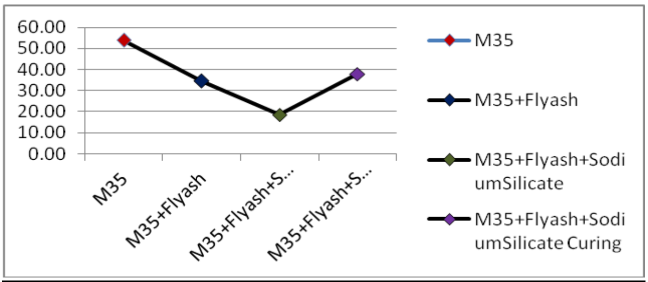
3 days



7 days

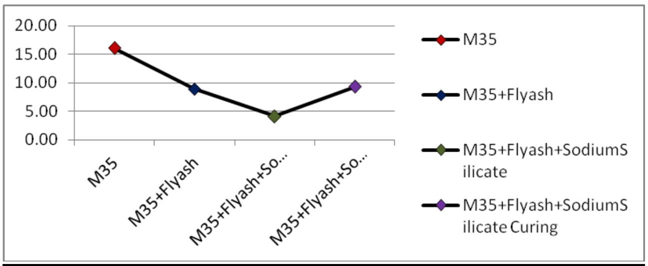


28 days



Graphical Representation of Cylinder Test

3 days



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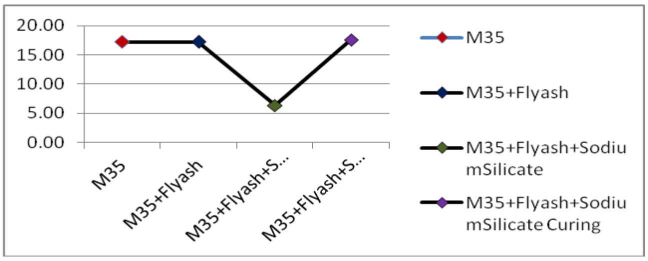

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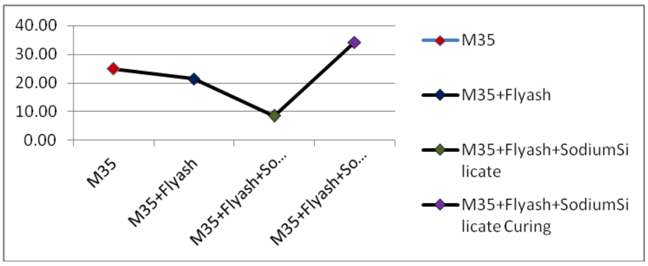
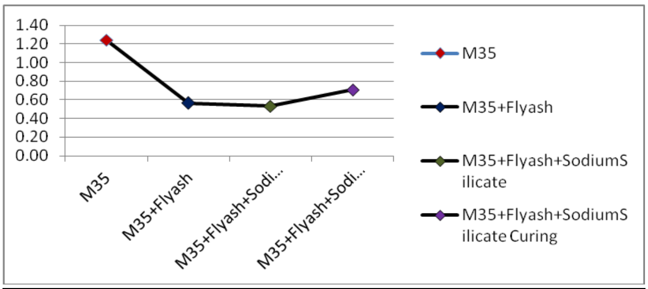
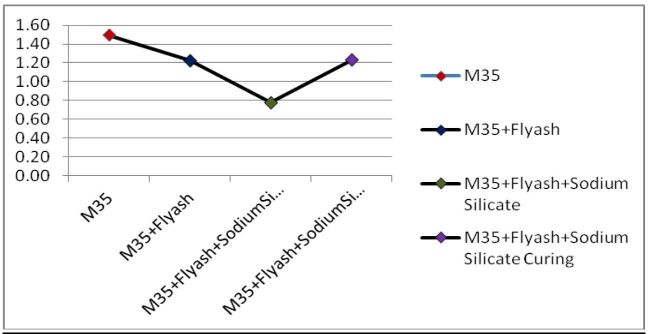


Graphical Representation of Flexure Strength

3 days



7 days



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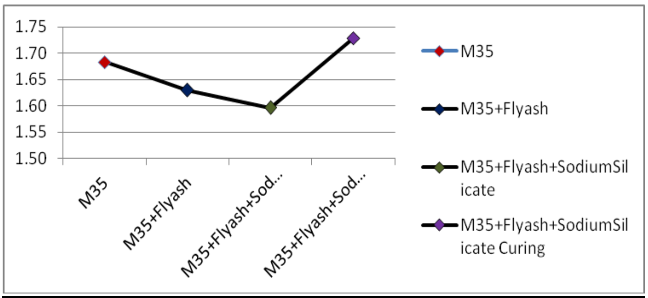

CARBONATION

3. CONCLUSIONS

In order to increase resistance to the external chloride penetration of concrete structures in saline environments, sodium silicate as mixing and sodium silicate as surface treatment were used along with partial replacement of cement and fly ash.

The following discussions can be drawn from the 3 experiments tested in this study

1) Results were not satisfactory , when the concrete is mixed with sodium silicate(5%). In every case the results were below par with the results of normal concrete and concrete with flyash. The reason could be attributed improper bonding of silicates with concrete and sufficient green bond strength was not achieved. The other reason could be amount of sodium silicate inclusion could be small.
2) Sodium silicate when used as surface treatment, at the early age results were similar to that with concrete mixing with fly ash . But as the age goes on increasing, there was increase in strength when compared fly ash mixing with normal concrete.The reason could be attributed to
a) Reduction of chloride diffusion coefficient
b) Reduction of immersion of water absorbtion of concrete
3) For durability assessment , carbonation test was conducted . It shows a particular significant change according to the mixed amount of OPC in the binder.

Pink colour indicates carbonation is done to a lesser extent because of the prensence of $Ca(OH)_2$.
Carbonation resistance was superior in sodium silicate as surface treatment when compared to other three mix proportions.

From the above discussion it can be concluded that

- sodium silicate in freshly mixed portland cement has the effect of raising the pH of the pore fluids as well as maintaining a elevated level of silicon ions in these fluids.
- In cement fly ash and dust based stabilization systems, the gelling time can be controlled from half minute to half an hour , instead of 24 -48 hours.
- Sodium silicate as surface coating can extend the service life significantly, if exposed to chloride contaminated solutions. But care should be taken that , the attack is not from the external factors ,which directly affects the covering property.

SCOPE OF STUDY

- Discussion related to silica fume as admixture can be studied
- Discussion with respect to different temperature can be studied
- Comparision with other binding materials like polyuretehne coating, silane/siloxane can be studied.
- Comparision with other chemicals like linseed oil, turpentine oil can be studied.

Surface Treatment with Sodium Silicate

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