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Experimental Investigation on Corrosion Resistance of Steel using Chemcal and Increasing Strength of Concrete using Silica Fume

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Abstract— This project presents the result of experimental investigation which was done regarding the corrosion resistance in steel by the addition of zinc phosphate and by the same time increment in the strength of concrete by replacement of cement with silica fume. The experimental study explains the influence of silica fume on the strength of concrete on replacement ratios of 5%, 10%, 15% as well as resistance attained by steel bars after the immersion in the zinc phosphate bath. The results shows that the concrete gained good strength with the addition of silica fume up to 10% and there was slight fall in the compressive strength value when the replacement in made with 15% of silica fume.
Key words: Corrosion Resistance, Zinc Phosphate, Silica Fume, Compressive Strength, Split Tensile Strength, Flexural Strength

I. Introduction

Standard terminology defines corrosion as “the chemical or electrochemical reaction between a material, usually a metal, and its environment that products a deterioration of the material and its properties”. Corrosion produces pits or holes in the surface of reinforcing steel, reducing the strength capacity as a result of the reduced cross sectional area.

The main concept of the project is to resist the corrosion of the steel in concrete. Corrosion is multi-faceted phenomenon that adversely affects and causes deterioration through oxidation. Millions of dollars loss throughout the metal industry can be attributed to metal corrosion. Therefore this project helps in control and resistance of corrosion in steel. Silica fume is an artificial pozzolonic activity. It is by product from an electric arc furnace used in manufacture of silicon metal or silicon alloy. It has high silica content of more than 80%. It is excellent use as a Portland cement supplement.

II. Methodology

1) Studying literatures related to admixtures and used in concrete
2) Selection of materials based on its quality (cement, fine aggregate, coarse aggregate, water and other essential materials)
3) Calculating the ratio of mix proportions by mix design for the M25 grade of concrete.
4) Casting concrete specimens such as cube, cylinder and prism.
5) Water curing of concrete is done for 7days, 14days and 28 days.
6) Various strength tests are conducted on various concrete specimen for 7days, 14days 28days.

A. Materials used

1) OPC 53 grade (cement)
2) Fine aggregate (M sand)
3) Coarse aggregate
4) Water
5) Zinc phosphate
6) Silica fume

1) Ordinary Portland cement

The cement is a binding material. It consists of grinding the raw materials, mixing them intimately in certain proportion depending upon their purity and composition and burning them in kiln at a temperature of about 1300-1500 degree centigrade at which temperature.

Chemical composition of cement:

1) Lime(Cao) - 60 to 67%
2) Silica(sio2) - 17 to 25%
3) Alumina(Al2O3) - 3 to 8%
4) Iron oxide(Fe2O3) - 0.5 to 6%
5) Magnesia(Mgo) - 0.1 to 4%

2) M sand

Manufactured sand is produced from hard granite stone by crushing. The crushed sand is a cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand is less than 4.75mm. locally available M sand was used for our experiment below the size of 4.75mm. specific gravity of fine aggregate is 2.62.

3) Coarse aggregate

The aggregate having size more than 4.75mm as termed as coarse aggregate. Locally available crushed coarse aggregate of size 20mmwas used in our experiment. The specific gravity of coarse aggregate is 2.72

4) Water

Portable water free from impurities and salt used for casting and curing the concrete blocks as per IS456 – 2000.

5) Silica fume

The specific gravity of the silica fume concrete is 2.2. particle size is less than 1 micron with average diameter of 0.1 micron. The shape of the particle is spherical. Colour of silica fume is pure white.

6) zinc phosphate

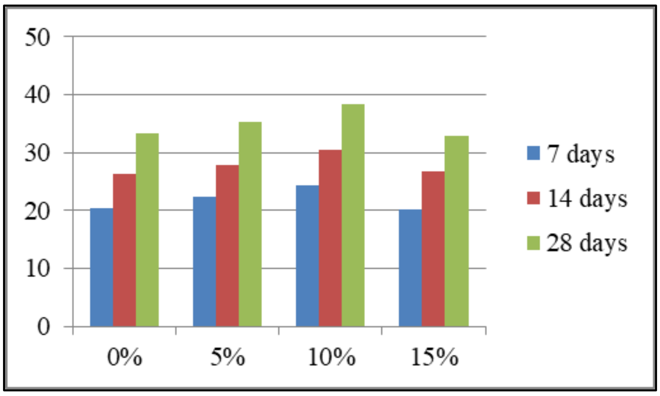
Phosphate coatings are used on steel parts for corrosion resistance. zinc phosphate are used for corrosion resistance. And coating was applied by immersion of steel. in our experiment steel was immersed in zinc phosphate bat

III. Results and Discussion

The average compressive strength test, split tensile strength test and flexural strength test readings after 7days, 14 days, and 28 days are listed below.

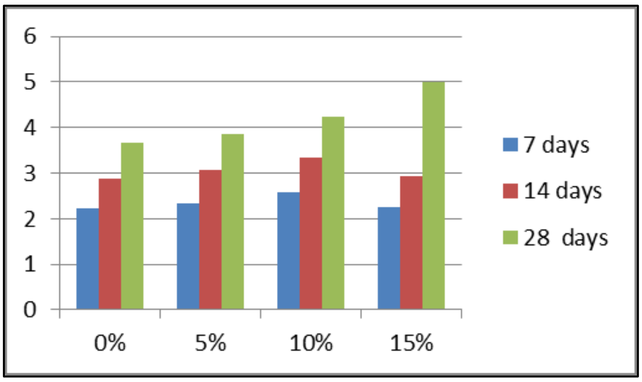
Silica fume %	Compressive strength (N/mm^2)		
	7 days	14 days	28 days
0%	20.44	26.22	33.33
5%	22.3	27.9	35.21
10%	24.4	30.55	38.45
15%	20.22	26.67	32.98

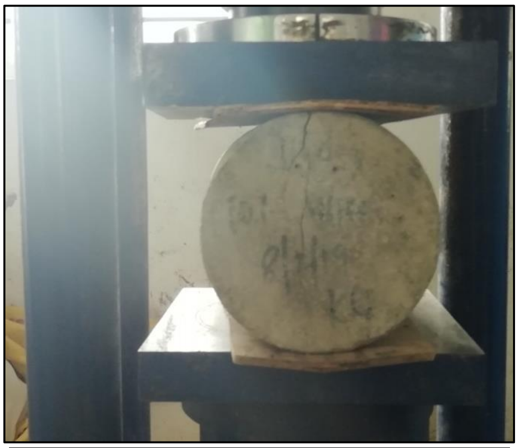
Table 1: Effect of silica fume on compressive strength of concrete



Silica fume %	Split tensile strength (N/mm^2)		
	7 days	14 days	28 days
0%	2.248	2.88	3.66
5%	2.34	3.06	3.87
10%	2.68	3.352	4.239
15%	2.242	2.293	3.62

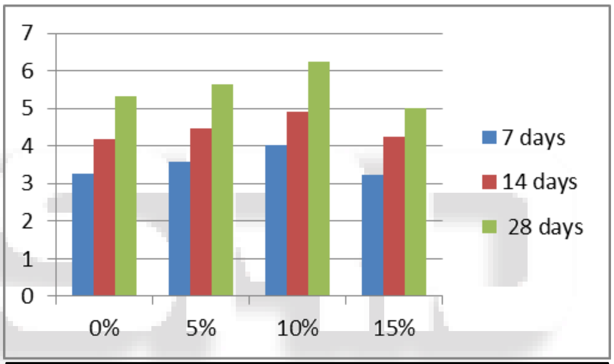
Table 2: of Effect of silica fume on split tensile strength of concrete





Silica fume %	Flexural strength (N/mm^2)		
	7 days	14 days	28 days
0%	3.27	4.19	5.33
5%	3.57	4.46	5.64
10%	4.02	4.9	6.23
15%	3.23	4.26	5.37

Table 3: Effect of silica fume on flexural strength on concrete



IV. STEEL CORROSION RESISTANCE TEST

A. Polarization test

Polarization teat or impressed voltage test was performed to ascertain the durability of different mixes. This test is based on electrochemical polarization principle. The procedure for performing the polarization the test its experimental setup is explained in the following

To assess the corrosion protection efficiency under accelerated test condition, concrete cylinder size of specified size were cast and having a pvc sleeve at the top of the steel rod. Concrete cylinders were cast of size 85mm diameter and 150mm length with centrally placed steel rod of 16mm diameter. The steel rod is placed in such a way that a constant cover is maintained all round.

The experimental setup consists of DC power pack, a nonmetallic container, in which water is mixed with 3.5% Nacl solution and filled to the required level the test specimen were subjected to a constant voltage 6 volts from the D.C power pack.

The current response is monitored with time during polarization test. As experimental is continued, the current will increase indicating the corrosion progression. The experiment is discontinued after observing the first crack on the concrete surface. It indicates the initiation time and the propagation time. Initiation is the time for which the constant potential is maintained at the rebar and propagation time is the increase in the potential at the rebar when corrosion process in propagation

V. CONCLUSIONS

Based on the analysis of experimental results and discussion the following conclusions can be drawn

Upon the addition of silica fume the strength of the concrete specimen. The optimum value of silica fume addition was found to be 10%. The compressive strength and flexural strength has fallen upon the addition of 15% of silica fume. The split tensile strength kept increasing on the addition of silica fume.

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