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Reduction in Chloride Penetration by Use Of Steel Mill Scrap in Concrete

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Abstract:

Corrosion is one of the major drawbacks of the use of Steel as reinforcement in Concrete (RCC). The rate of Corrosion can be found by performing Rapid Chloride Penetration Test (RCPT) according to ASTM – C 1202. This test is conducted on a sample of Concrete of Cylindrical shape, of 50 mm height and 100 mm diameter, which is cured for 28 and 56 days. The chloride penetration value helps in determining the rate of corrosion of Concrete. In this project, we aim to reduce the chloride penetration value by addition of Steel mill scrap in Concrete. Four samples were prepared, namely, Control mix, 10 kg/cu.m addition, 20 kg/cu.m addition and 30 kg/cu.m addition of the Steel mill scrap. The Control mix was prepared to act as a benchmark for the Chloride Penetration value. The test was conducted, and the results showed a reduction in Chloride penetration value as the quantity of the Steel mill scrap was increased.

Keywords: ***Chloride, Concrete, Corrosion, Permeability, RCPT***

I. Introduction

Concrete is very strong against compressive loads, but weak in tension. So, the concept of Reinforced Cement Concrete was introduced in civil engineering. But, one of the major factors influencing the steel usage is its corrosion rate. Steel can be easily corroded by many means. To overcome this hurdle, the Chloride permeability of the concrete is tested. The rate of corrosion is directly proportional to the Chloride permeability. Higher the permeability, higher the corrosion.

In this project, we casted concrete with steel scrap as four batches namely Control mix, 10 kg addition, 20 kg addition and 30 kg addition of steel scrap, and it was cured for 28 and 56 days. To test the chloride permeability, Rapid chloride penetration test was carried out according to ASTM – C 1202.

II. Methods

A concrete mix of Water, Cement (PPC 53G M30), Coarse aggregate (20 mm & 12.5 mm), Fine aggregate (crushed sand), Steel mill scrap (passing through 4.75 mm IS Sieve and retained in 2.36 mm IS Sieve), and Admixture (SUPAFLO SPL) is casted and cured for 3, 7, 28 and 56 days. The mix types were Control mix, 10 kg/cu.m addition of steel mill scrap, 20 kg/cu.m addition of steel mill scrap and 30 kg/cu.m addition of steel mill scrap.

These were casted in a rubber mould of inner dimensions of 50 mm height and 100 mm in diameter. After 28 and 56 days of curing, the samples were tested in a laboratory for its chloride permeability, in a non-destructive way.

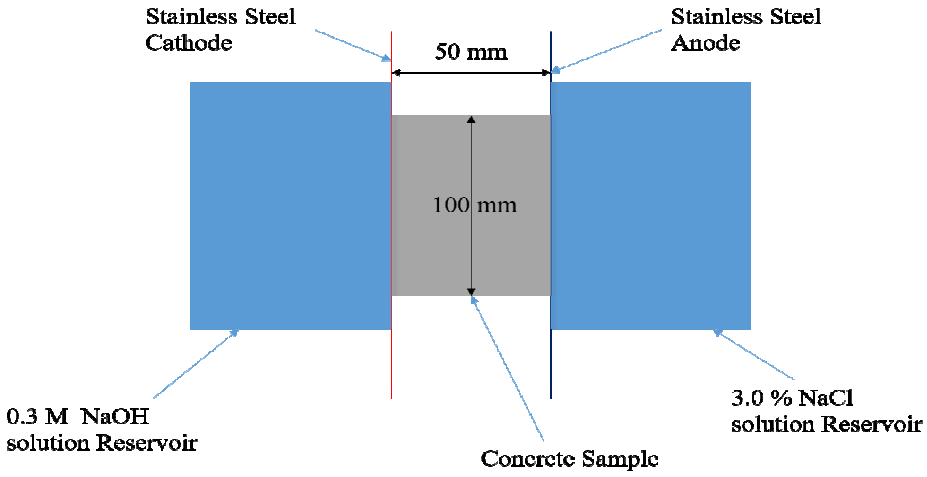

Fig. 1 - Apparatus setup for RCPT

The formula used to find the average current flow through one cell is,

$$Q = 900\ ((I_0 + I_{360}) + 2(I_{30} + I_{60} + I_{90} + I_{120} + I_{150} + \ldots\ldots + I_{360}))$$

Where,

Q = Current flow (coulombs)

I_0 = Current Reading in amperes immediately after application of Voltage

I_t = Current reading in amperes at t minutes after voltage is applied.

III. Results

Table 1- Material test report on Rapid Chloride Penetration test

ID	Date of Casting	Dater of Testing	RCPT Value (in Coulombs)	Average RCPT Value	Chloride Permeability as per ASTM – C 1202
1875	30-01-2016	17-03-2016	702	660	Very Low
			618		
1876	02-02-2016	17-03-2016	780	708	Very Low
			670		
			677		
1877	03-02-2016	16-03-2016	482	652	Very Low
			658		
			815		
1878	04-02-2016	16-03-2016	626	578	Very Low
			564		
			543		

Table – 2 Permissible limits for RCPT

Charge passing	Chloride Permeability
> 4000	High
2001 – 4000	Moderate
1001 – 2000	Low
100 – 1000	Very low
< 100	Negligible

IV. Discussions

The Rapid chloride penetration test (RCPT) was conducted for samples of all the mixes (according to ASTM – C 1202) and their values were obtained as given in Table – 2. The Charge passing through the Control mix sample had a higher penetration value than the addition batches. In fact, the 30 kg addition of steel mill scrap sample showed a lower penetration value than all the other batches casted.

V. Summary and conclusions

The values obtained after the test showed that the concrete samples from all the batches has very low Chloride penetration value, which suggests that the concrete will have a lower rate of corrosion. Also, the addition of steel mill scrap has reduced the chloride penetration value of Concrete. This can be observed from the decrease in the Coulombs passing value as the quantity of addition of steel scrap increases.

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