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Corrosion study of mild steel, tor steel and CRS steel by weight loss method

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Abstract

In present investigation an attempt has been made to investigate corrosion rate of mild steel, Tor steel and CRS steel in reinforced concrete. The five concrete block sites have been selected. The factor causing corrosion and conditions of the environment has been studied. Attempt has been made to consider conditions which will help to get greater protection against corrosion problem for industries as well as household articles.

Key words: Mild steel, Tor steel, CRS steel.

Introduction

Corrosion is the destructive attack on a metal or a metal alloy by chemical or electrochemical reaction with its environment [1]. Metal and its alloys tend themselves to many engineering application because of their combination of lightness with strength, thermal and electrochemical conductivity, reflectivity and non toxic qualities [2]. Iron is used in the form of stainless steel for making cutlery, hospital and food service equipment. Carbon steel is the most common, cheapest and most versatile metal used in industry. Due to wide range of applications of alloy in our day to day life. The corrosion study of metal in an analytical importance.

Corrosion is disintegration of material into its constituent atom due to chemical reaction with its surroundings. The loss of electrons of metal reacting with water and oxygen. Weakening of iron due to oxidation of the iron atoms is a well known example of electrochemical corrosion. Although in this context, the term degradation is more common. Most structural alloys corrode merely from exposure to moisture in the air. But the process can be strongly affected by exposure to certain substances. Corrosion can be concentrated locally to form a pit or crack, or it can extend across a wide area to produce general deterioration[1]. There are different factors

influencing corrosion such as acids, oxidizing agents and temperature. Even though a number of factors are responsible for early distress in reinforced concrete structure it is observed that in the majority of cases it is because corrosion of steel. The problem is wide spread in India due to the peninsula being surrounded by sea, hot and humid climate and also aggressive environmental conditions created by industrial development of the country. Proposed work was under taken for the systematic study of corrosion.

Materials and methods

Weight loss method- this is the simplest and most convenient method than the all other method. In this method the initial dimensions such as length, diameter and weight of the specimen are measured accurately and then they are embedded in the concrete. After that reinforced concrete is exposed the artificially created or natural available environment for the course of time known as exposure duration. After the exposure duration the concrete blocks are taken out, broken and then specimen are removed from concrete, and then they are again cleaned and weighed. Thus the loss in this obtained and corrosion rate is found from the formula given below.

Corrosion rate mm/year = 87.6 W/DAT

Where

W= weight loss in milligrams
D= Density of steel in gm/cm^3
A= Surface area of steel in cm^2
T= Time of exposure in hours

Practical method

The steel bars used for the work are first completely polished with polish paper to remove all the rust then surface are and weight of each bar is measured accurately were embedded inside the concrete blocks were crushed for taking out the bars. The adhering concrete to the surface of the bars was scraped off. Then the bars were cleaned in CLARCKS solution as explained in below. Then the bars were dipped in the solution for 10 to 15 min depending upon the extent of rust formation loss in weight for each bar was found.

Clearcks solution

Practically, it is not easy to clean the specimen embedded in concrete due to good bond between steel surface and cement past. Though we can use clarcks solution to clean and dissolve the very small quantity of uncorroded steel @ 0.2 mg/cm^2 usually it reacts with uncorroded steel very less. Clearcks solution consist of, for one liter of concentrated hydrochloric acid 20 g of antimony oxide (Sb_2O_3) 50 g of tin chloride ($SnCl_2$).

Result and Discussion

Method of weight loss is suitable to check the various type of steels available in the market under accelerated corrosion atmosphere in the laboratory, the test results represents Table 1, shows that bars are smaller cover depth get more affected since the weight loss was found more. Corrosion rate due to more cations and anions present in water such as chlorides, sulphate, calcium, magnesium and sodium [3]. Corrosion of mild steel and S–S–304 particularly due to dissolved oxygen present in ground water [4]. The chlorides and sulphates are highly aggressive to corrosion point of view and their concentration is also important. Corrosion of metal immersed in water is however controlled by amount of dissolved oxygen. [5-6].

Table 1. Corrosion Rate by Weight Loss Method

Position of bar	Cover in mm	Length of bar in mm	Dia.of bar in mm	Initial weight in g (W_1)	Final weight in g (W_2)	Weight loss in gms $W=(W_1-W_2)$	Surface area $A=L2\pi r$	Corrosion rate mm/yr	% wt loss $W/W_1\times100$
1	10	48	10	280.19	280.00	0.19	150.79	0.4848	0.0667
2	10	48	10	379.17	278.96	0.21	150.79	0.5574	0.0770
3	30	44	10	267.57	267.43	0.14	138.23	0.2404	0.0317
4	30	44	10	263.52	263.21	0.11	138.23	0.2969	0.0398
5	45	41	10	249.57	249.50	--	--	--	--

a) Concrete Block No : A-1
Type of steel: Mild steel

Position of bar	Cover in mm	Length of bar in mm	Dia.of bar in mm	Initial weight in g (W_1)	Final weight in g (W_2)	Weight loss in gms $W=(W_1-W_2)$	Surface area $A=L2\pi r$	Corrosion rate mm/yr	% wt loss $W/W_1\times100$
1	10	48	10	280.00	279.82	0.18	150.79	0.4589	0.0632
2	10	48	10	275.57	275.33	0.24	150.79	0.4796	0.0671
3	30	44	10	264.12	264.04	0.08	138.23	0.2178	0.0291
4	30	44	10	266.24	266.15	0.09	138.23	0.2404	0.0902
5	45	41	10	249.50	249.49	--	--	--	--

b) Concrete Block No : A-2
Type of steel: Mild steel

Position of bar	Cover in mm	Length of bar in mm	Dia.of bar in mm	Initial weight in g (W_1)	Final weight in g (W_2)	Weight loss in gms $W=(W_1-W_2)$	Surface area $A=L2\pi r$	Corrosion rate mm/yr	% wt loss $W/W_1\times100$
1	10	48	12	385.37	384.77	0.600	180.95	1.29	0.1556
2	10	48	12	385.17	384.37	0.805	180.95	1.73	0.2089
3	30	44	12	379.37	379.00	0.370	165.87	0.86	0.0962
4	30	44	12	383.50	383.10	0.400	165.87	0.94	0.1043
5	45	41	12	347.34	347.18	0.161	154.56	0.41	0.0463

c) Concrete Block No: A-3
Type of steel: Tor steel

Position of bar	Cover in mm	Length of bar in mm	Dia.of bar in mm	Initial weight in g (W_1)	Final weight in g (W_2)	Weight loss in gms $W=(W_1-W_2)$	Surface area $A=L2\pi r$	Corrosion rate mm/yr	% wt loss $W/W_1\times100$
1	10	48	12	396.57	395.86	0.645	180.95	1.39	0.1626
2	10	48	12	392.35	391.49	0.862	180.95	1.86	0.2196
3	30	44	12	382.37	382.05	0.315	165.87	0.74	0.0823
4	30	44	12	385.35	385.07	0.280	165.87	0.66	0.0726
5	45	41	12	348.35	348.30	0.050	154.56	0.136	0.0155

d)Concrete Block No: A-4
Type of steel: Tor steel

Position of bar	Cover in mm	Length of bar in mm	Dia.of bar in mm	Initial weight in g (W_1)	Final weight in g (W_2)	Weight loss in gms $W=(W_1-W_2)$	Surface area $A=L2\pi r$	Corrosion rate mm/yr	% wt loss $W/W_1\times100$
1	10	48	12	439.21	439.15	--	--	--	--
2	10	48	12	440.15	440.00	--	--	--	--
3	30	44	12	403.52	403.35	--	--	--	--
4	30	44	12	404.50	404.35	--	--	--	--
5	45	41	12	379.40	379.21	--	--	--	--

e)Concrete Block No : A-5

Type of steel: CRS steel

Time for exposure = 7 days; Grade of concrete = M15; Water cement ratio = 0.4 Density of Steel (D) = 7.78 gms/cm^3; Surface area of steel A=L2πrL.

Conclusion

- Corrosion knowledge is very important for planning to reduces corrosion.
- The corrosion rate is found more for tor steel than mild steel.
- A major cause of corrosion related problem in service is that the provisions in the specifications are not followed properly such as water cement ratio, depth of cover, quality of water and quality of aggregate.

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