Evaluation of Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) to protect the embedded steel in concrete from corrosion

Final Project Report

Submitted to

M/s. Laal Chemicals
Chennai

Submitted by

Corrosion & Materials Protection Division
CSIR – Central Electrochemical Research Institute
Karaikudi – 630 003, Tamilnadu

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TITLE OF THE PROJECT

Evaluation of Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) to protect the embedded steel in concrete from corrosion Sponsored

Project Number: SSP 23/22

Project Period: 11-11-2022 to 31-12-2023

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Main Objective: **The required test for Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) consists of both short term and long term tests. In this project, BCPCIA of M/s. Laal Chemicals, Chennai was evaluated for its efficiency.**

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1. Introduction

In industrial applications, inhibitors are the first line of defense against corrosion. Inhibitors slow down the corrosion process by: increasing the anodic or cathodic polarization behavior; reducing the movement of ions of the metallic surface; increasing the electrical resistance of the metallic surface. Commercially available inhibitors are only known by their trade names that provide very little information on their composition. Commercial inhibitor formulations may consist of one or more inhibitor compounds, accompanied with other additives such as surfactants, film enhancers, de-emulsifiers, and oxygen scavengers.

2. Objectives

The objectives of the project is to evaluate the bipolar inhibiting nature of corrostop-15 of M/s. Laal chemicals, Chennai. The test for Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) consists of both short term and long term tests. In this report BCPCIA represent Corrostop-15 of M/s. Laal Chemicals, Chennai.

2.1 Short term test

- Appearance, odour, skin irritation, pH, specific gravity and viscosity of the inhibitor.
- Accelerated corrosion test to be carried out in raw water with 1% (BCPCIA) and without inhibitor for 21 hours.

2.2 Long term test

- Immersion test for 720 hours (rebar weight loss method) with 1% BCPCIA and without BCPCIA in raw water as per ASTM G 1 – 03 (2017)
- Effect of concrete admixture on compressive strength with 1% BCPCIA and without BCPCIA in raw water as per IS 9103 – 1999 (reaffirmed 2018 or its latest version)
- Polarization test by Tafel polarization in 3.5% NaCl with 1% BCPCIA and without BCPCIA for 20 days as per ASTM G 3 - 14.
- Effect of BCPCIA on corrosion of embedded steel rebars exposed to chloride environments after 9 cycles (14 days wetting and 14 days drying) with 1% BCPCIA and without BCPCIA as per ASTM G – 109.
- The passing criteria / requirements for the entire above tests are according to the RDSO specification No. M&C/PCN/126 / 2020 (Rev.1.0) and ASTM G109.

2.3 System studied

Corrostop -15 manufactured by M/s. Laal Chemicals, Chennai was used as Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA).

3. Experimental details

3.1. Short term test

The requirement of bipolar concrete penetrating corrosion inhibiting admixture (BCPCIA–corrostop-15) to be tested as follows:

Sl. No.	Characteristics	Method of test
1	Appearance	Visually
2	Odour	By smell
3	Skin irritation	By applying on reverse of the palm for 5 minutes
4	pH	
4a	As in supplied condition	pH meter / Standard pH paper
4b	1% dilution (w/w)	
5	Specific gravity	IS 1448-2014
6	Viscosity of the material as in supplied condition, by Ford Cup No.4, at 27± 2°C	IS 101 (Pt. 1/Sec 5)-1989, Reaffirmed 2019
7	Accelerated corrosion test for 21 hrs.	
7a	Raw water without BCPCIA	Procedure is given below in section 3.1.2
7b	Raw water with BCPCIA	

3.1.1. Physical tests

The appearance of the bipolar corrosion inhibitor (Corrostop-15) as supplied by Laal chemicals is given in Fig.1.

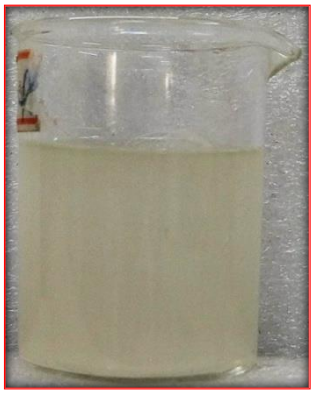

Fig.1 Bipolar corrosion inhibitor as supplied by M/s. Laal chemicals

The specific gravity and viscosity are measured as per standards. The setup for viscosity measurement is shown in Fig.2.

Fig.2 Viscosity setup

The pH of the bipolar corrosion inhibitor as in supplied condition and in 1% dilution (w/w) is shown in Figs.3a and 3b respectively.

Fig.3a. supplied condition

Fig.3b. 1% dilution

Fig.3 pH of Corrostop-15 measurement is in progress

3.1.2 Modified accelerated corrosion test (based on Japanese Standard JISZ 1535)

TMT rebar of size 16 mm dia. and 12 mm thickness drilled from one side to a dia. of 10 mm and a depth of 10 mm to hold the aluminium pipe. After thorough cleaning with different grades of emery paper to the aluminium pipe with the help of cello tape so that it is firmly attached. The aluminium pipe is then slide upwards till the test rod in the slit provided in the rubber cork as shown in Fig.4.

Fig. 4 Test setup for accelerated corrosion test

Pour 100 ml of tap water in both the bottles. Fill the plastic cup with 25 ml of BCPCIA solution as in supplied condition. In one of the bottles, place the plastic cup with BCPCIA solution so that the cup is placed in the tap water as shown in Fig. 5.

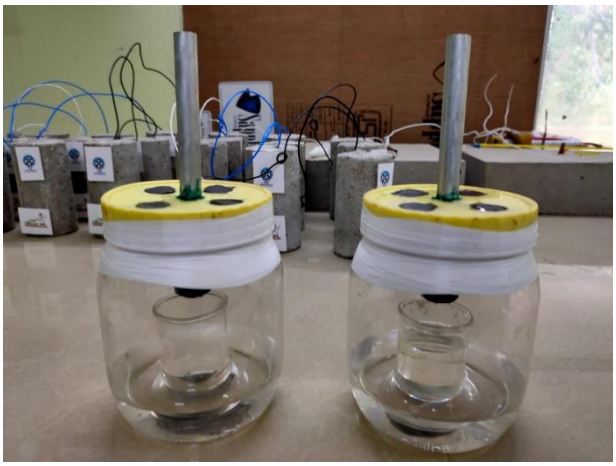

Fig. 5 Plastic cup with and without BCPCIA

Allow to remain for 18 hrs at ambient temperature. After 18 hrs, add chilled and cold water having temperature below 1°C into the aluminium pipes and allow remaining for 3 hrs. The temperature of the chilled water in the aluminium pipe shall be maintained at 2±0.5°C by frequently changing the chilled water with help of pipette. Observe the steel rebar test pieces after the experiment at the end of (18+3 = 21 hrs) for any corrosion spots.

3.2 Long term test

3.2.1 Immersion Test (Rebar weight loss test) (As per ASTM G-I)

TMT steel rebar conforming to IS:1780-2008 of size approx. 40 mm length and 10 mm dia. was taken and the rebar was cleaned for any rust, mill scale etc., with the help of steel wire brush, till it has overall a shining surface. Now all the six pieces were cleaned with solvent such as acetone to remove the loose rust /dust from the surface. Dry at 100±2°C for 15 minutes in an oven. Cool and take the weights of all the six pieces and record it.

Take six transparent plastic bottles of capacity approximately 150±10 ml with air tight caps. Clean all the bottles with tap water and then fill them with 100 ml of tap water so that the bottles are approximately three fourth filled. In three of the six bottles, add BCPCIA 1% w/w in the bottle. Now put one cleaned and weighed rebar test piece completely immersed in water / water + BCPCIA, in all the six bottles and close the cap.

After 30 days (720 hrs) take out all the six test pieces and put them in Clark solution (prepared by dissolving 20 gms. of antimony trioxide and 50 gms of stannous chloride in 1000 ml of con. hydrochloric acid S.G. 1.18) so that corrosion products are dissolved. After complete removal of corrosion products (in 5 minutes approximate), take out the test pieces and wash in running water and finally with distilled water. Then wash the test pieces, with solvent such as benzene/acetone. Dry at (100 ± 2)°C for 30 minutes in an oven. Cool and take the weights of all the six pieces and record it.

Calculate the corrosion rate in mpy, by using the formula

$$\text{Corrosion rate (mpy)} = 534 * W / D*A*T$$

where W = W1-W2 is the weight loss in mg, D is the density of steel, A is the area in sq. inch and T is the time of exposure in hrs (720 hrs).

The initial weight of the rebar was taken using 4 digit electronic balance. The experimental setup for immersion test is shown in Fig.6.

Fig.6 Experimental setup for immersion test

3.2.2 Test for effect of compressive strength by addition of BPCIA

Cast three concrete cubes of size 100 mm×100 mm×100 mm each with BCPCIA (1% Corrstop-15) and without BCPCIA. The design mix was M30 grade (IS: 9103 1999 reaffirmed in 2018). The concrete cubes casted shall be demoulded after 24 hours. These concrete cubes shall be cured for 28 days in distilled water. After completion of the curing period each concrete cube is subjected to universal compressive testing machine (UTM) and data was recorded. The compressive strength test measurement in progress is given in Fig. 7.

Fig. 7 Compressive strength test experiment is in progress

3.2.3 Electrochemical polarisation test

The brief outlines of the electrochemical polarization test on steel rebars embedded in concrete is follows as per ASTM G 3-14 (2019).

Cast three concrete cylinders, of size 75 mm diameter and 150 mm length each without and with BCPCIA 1% (w/w) of cement, by casting the concrete of M30 grade as per IS 9103-1999 (Reaffirmed 2018), and placement or one cleaned rebar conforming to IS:1786-2008 of size 375 mm length and 12 mm dia. (preferably cleaned by pickling in hydrochloric acid 20% (v/v) approximately, till surface shines and washed in running water) in each block. The above casted blocks shall be de-moulded after 24 hrs. These blocks shall be moist cured for 28 days. After completion of the curing period, the blocks shall be subjected for polarization test for 20 days as per ASTM G-3-14 (2019) and observations recorded. The concrete cylinders admixed with BCPCIA is shown in Fig.8.

Fig.8 Concrete cylinders for polarization test

The polarization was conducted potentiodynamically in a conventional three electrode setup. Here, rebar embedded in concrete cylinder act as a working electrode, perforated stainless steel act as a counter electrode and saturated calomel electrode (SCE) served as the reference

electrode. AR grade NaCl is used to prepare electrolyte solution. The electrolyte was 3.5% NaCl solution. Tafel polarisation was conducted using advanced corrosion monitoring machine (ACM field machine, UK). The initial measurements were recorded for all the systems. The final exposure will be at the end of 20 days. The electrochemical studies in progress is shown in Fig.9

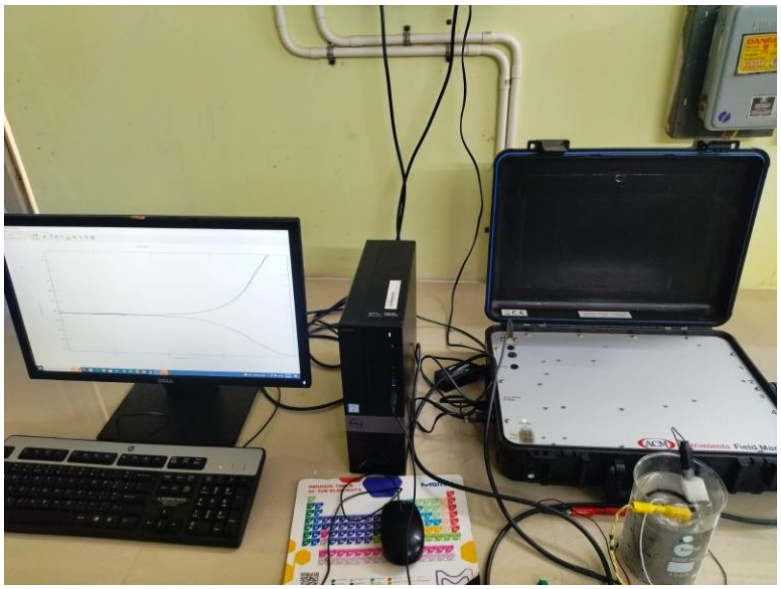

Fig.9 Electrochemical tests in progress

3.2.4 Macrocell corrosion test

The brief outline of long term corrosion test as per ASTM G 109-2007 (2013) is given below.

Three specimens each of control concrete and that of BCPCIA admixed concrete (1% W/W of cement) should be cast as per the size 280 mm × 150 mm × 115 mm and with the placement of three cleaned reinforcement bars conforming to IS:1786-2008 (preferably cleaned by picking in hydrochloric acid 20% (v/v) approx. till surface shines and washed in running water).

Two rebars were embedded at 25mm from the bottom and one rebar is placed at 25mm from the top surface. Both ends of the rebars (40 mm approx.) were sealed with wax/epoxy to avoid edge effects. The total exposed length of the rebar was 200 cm after masking both the edges of 40 mm each side. Triplicate concrete specimens were cast with & without inhibitor by following the procedure mentioned in ASTM G 109. The casted specimens were moist cured for 28 days. After 28 days curing, Plexiglas dam was constructed for ponding of 3.5% NaCl

solution. After ponding of 3.5% NaCl the top and bottom rebars were connected with 100 Ω resistor.

The measurement of voltage across 100 ohm resistor was taken at the beginning of the second week (14 days) of ponding. Current I, was calculated from the measured voltage and recorded. Also measured the corrosion potential of the bars against saturated calomel reference electrode. The experiment should be continued till the macro cell current reaches a value of 10 µA. After the exposure period break the specimens and examine the rebars for extent of corrosion, measure the corroded area and recorded. The macrocell specimens at CSIR-CECRI exposure yard is shown in Fig.10.

Fig .10 Macrocell specimen exposed at CSIR-CECRI exposure yard

The anode potential and the macro-cell current flow between anode and cathode were recorded periodically.

4. Results and Discussion

4.1 Short term test

The results of the short term test for bipolar inhibitor are given below:

Table 1 Results for short term test of BCPCIA (corrostop-15)

Sl. No.	Characteristics	Results
1	Appearance	Ivory
2	Odour	Not pungent
3	Skin irritation	No irritation
4	pH	
4a	As in supplied condition	12.74
4b	1% dilution (w/w)	11.43
5	Specific gravity	1.07
6	Viscosity of the material as in supplied condition, by Ford Cup No.4, at 27$\pm$ 2^{o}C	11.38 secs.
7	Accelerated corrosion test for 21 hrs.	
7a	Raw water without BCPCIA	excessive corrosion spots on the surface of the steel
7b	Raw water with BCPCIA	fewer corrosion spots on the surface of the steel

All the short term test results for Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) are given in above Table 1. Here it was noted that the bipolar inhibitor showed very clear liquid as shown in Fig.1. The very clear liquid showed by appearance passed the expected requirements. The smell of the inhibitor (Corrostop-15) was found not pungent, which is nothing detrimental to construction workers / applicators used in the field. No irritation was noticed on the back side of the palm even after five minutes. This is an additional advantage for the construction industries.

It is the fact that concrete pore solution having a pH of 12.5 to 13.0. Here it was interesting to note that the bipolar corrosion inhibitor (corrostop-15) showed 12.74 as in supplied condition. The pH (11.43) also does not altered even after 1% dilution. This is quite suitable to recommend to use BCPCIA in concrete.

The modified accelerated corrosion test (based on Japanese Standard JIS Z-1535) for BCPCIA inhibitor for 21 hours showed excessive corrosion spots on the surface of the steel. On the

other hand, raw water with BCPCIA showed very fewer corrosion spots on the surface of the steel. The test results are pictorially represented in Fig. 11.

Fig. 11 Accelerated corrosion test results

4.2 Long term test

4.2.1 Immersion test

Immersion test in raw water with and without inhibitor for 30 days is given in Table 2

Table: 2 Corrosion rate of steel obtained from immersion test for 720 hours

	Initial (g)	Final (g)	Weight loss (g)	Weight loss (mg)	Corrosion rate (mpy)
Without BCPCIA	34.3240	34.2359	0.0881	88.1	0.5053
	34.2798	34.1922	0.0876	87.6	0.5024
	33.2756	33.1859	0.0897	89.7	0.5144
	34.5092	34.4171	0.0921	92.1	0.5282
	34.7601	34.6705	0.0896	89.6	0.5139
	33.7719	33.6800	0.0919	91.9	0.5271
	Average corrosion rate = 0.5152				
With 1% BCPCIA (corrostop -15)	33.7416	33.6879	0.0537	53.7	0.3080
	34.7350	34.6811	0.0539	53.9	0.3091
	34.1258	34.0723	0.0535	53.5	0.3068
	34.6432	34.5891	0.0541	54.1	0.3103
	33.8456	33.7926	0.0530	53.0	0.3040
	35.0006	34.9472	0.0534	53.4	0.3063
	Average corrosion rate = 0.3074				

The average corrosion rate of rebar without BCPCIA was found to be 0.5152 mpy. However, the average corrosion rate of rebar with BCPCIA 1% was found to be 0.3074 mpy. Here it was observed that the lower corrosion rate was obtained for the inhibited system.

As per RDSO specification the requirements for corrosion rate of rebar during immersion test for 720 hours is 40 mpy (max.) for without BCPCIA and 2 mpy for with 1% BCPCIA.

In this study for 1% BCPCIA, the current rate is 0.3074 mpy which is less than 2 mpy.

Fig. 12 Photographs showing the rebar after weight loss experiment

Fig. 12 shows the photographs of the rebar after immersion experiment. Here it was noticed that the red rust was noticed on the surface of the rebar in control specimen. But, no significant rust was noticed on the surface of the rebar with 1% BCPCIA. Here it was concluded that BCPCIA (Corrstop-15) performed better and act as a good inhibitor for the immersion test of 720 hours.

4.2.2 Effect of Corrostop-15 on compressive strength

S.No.	Details	Data
1.	Cube	10 cm
2.	Area	10000 mm^2
3.	Tested Instrument	AIMIL Compressive Testing Machine
4.	Designed Mix	M30

The compressive strength was carried out for control specimen (without BCPCIA) and also with (1% BCPCIA) admixed concrete and data is given in the Fig. 13.

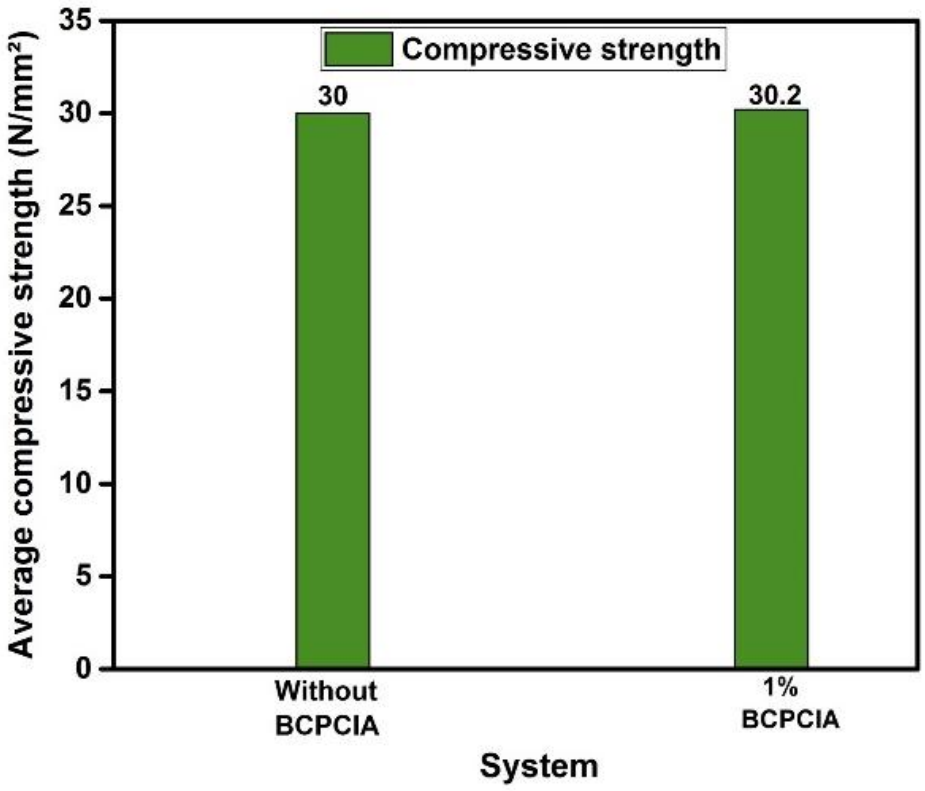

Fig. 13 Compressive strength vs. System

The compressive strength values for control concrete is 30 MPa. The addition of inhibitor into the concrete at 1% does not affect the compressive strength of the concrete. As per RDSO standard the concrete strength in sample with BCPCIA should be $\geq$ concrete strength in sample without BCPCIA. Here it was concluded that the addition of BCPCIA did not affected the compressive strength of concrete.

4.2.3 Polarization test by Tafel polarization with 3.5% NaCl for 20 days

Tafel polarization or (E vs Logi) plots were made by using potentiodynamic polarization technique. Polarization was carried out ± 250 mV from OCP for rebar without BCPCIA and with BCPCIA 1% (Corrostop–15). The sweep rate was 60 mV / min. The polarization plot for rebar at the end of 20 days immersion is given in Fig. 14.

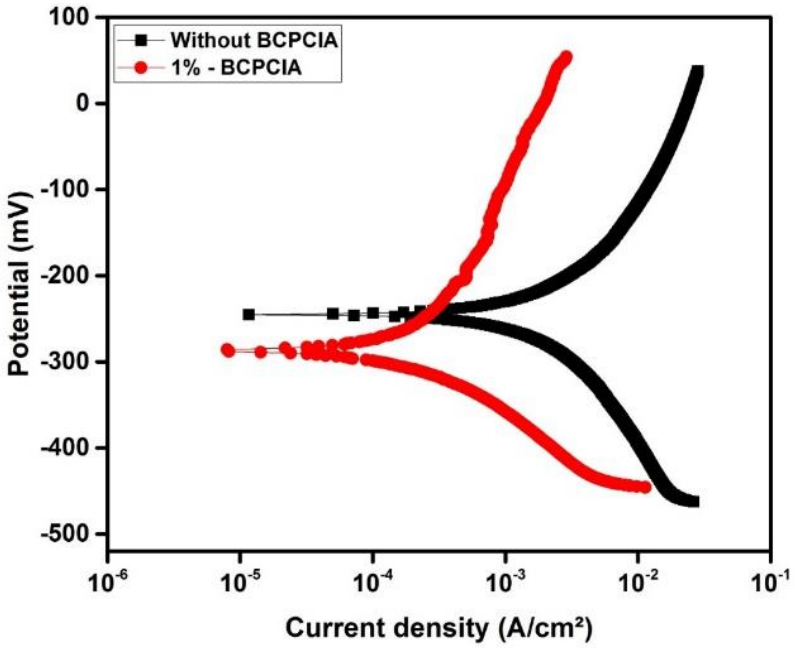

Fig.14 Tafel plots for steel rebar in 3.5% NaCl solution (20 days of immersion)

The corrosion kinetic parameters derived from the Fig.14 is given in the Table 4.

Table 4 Corrosion kinetic parameters for steel rebar in 3.5% NaCl solution derived from Tafel plots

System	Corrosion Kinetic Parameters		
	Corrosion Potential	Corrosion Current Density	Corrosion Rate
	E_{corr} (mV) vs SCE	I_{corr} (mA/cm^2)	CR (mpy)
Without BCPCIA	-244	0.00381	1.7373
With 1% BCPCIA	-287	0.00023	0.1059

Here it was observed that the corrosion rate for control specimen without BCPCIA showed more when compared to the corrosion rate of steel rebar with BCPCIA (1% Corrostop -15).

However, the RDSO specification specifies that the corrosion rate of the control specimen is 45 mpy max. and the corrosion rate of steel in inhibited specimen is 9 mpy max. Here it was interesting to note that the inhibited system showed less than 9 mpy indicating the better performance and passed the test as per RDSO standard requirements.

4.2.4 Effect of BCPCIA on corrosion of embedded steel rebars exposed to chloride environments after 9 cycles (14 days wetting and 14 days drying) as per ASTM G109.

4.2.4.1 Anode potential vs number of cycle of exposure

The anode potential was measured periodically with respect to the saturated calomel electrode (SCE) for the exposure period of 9 cycles (14 days wetting and 14 days drying consist of 1 cycle). Fig 15 shows the anode potential vs number of cycles of exposure.

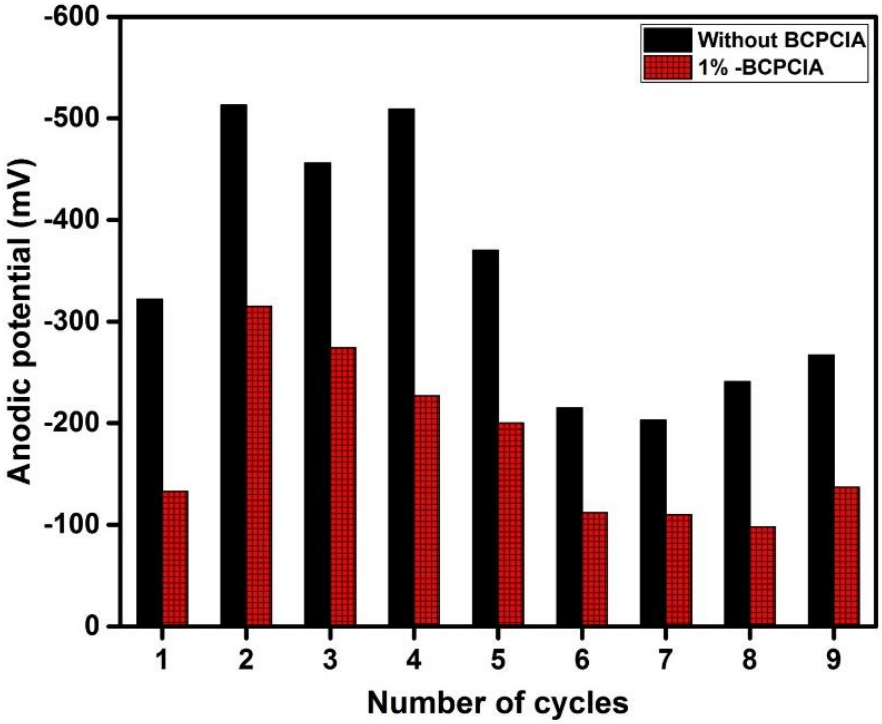

Fig. 15 Anode potential vs Number of cycles of exposure

Here it was observed from Fig. 15 that the potential of the rebar in the 1% BCPCIA system showed less negative potential when compared to the system without BCPCIA. It indicates the probability of the corrosion of rebar in the system without BCPCIA is more when compared to system with BCPCIA as per ASTM C876.

4.2.4.2 Macro cell current vs number of cycles of exposure

The macro cell current flow between anode and cathode was measured. The known resistor of 100 ohm is connected between the anode and cathode. The macro cell current measured was converted into coulombs as defined in ASTM G 109 and reported in Table 5. RDSO specification specify the values of 25 coulombs, max. for without BCPCIA and 0.5 coulombs, max. for with 1% BCPCIA.

Table 5 Macrocell Parameters

System	Expected requirements	Results obtained
Without BCPCIA	25 coulombs, max.	32 coulombs
With 1% BCPCIA	0.5 coulombs, max.	0 coulombs

It was observed from Table 5 that the system admixed with 1% BCPCIA (Corrostop-15) effectively protected the rebar from corrosion and thereby reduced the macrocell current. Here it was concluded that the corrostop-15 performed better as bipolar corrosion inhibitor even in the very aggressive marine environment such as in 3.5% NaCl solution.

4.2.4.3 Visual observation of the rebar

At the end of the 9^{th} cycle the macro cell specimens were split open and carefully removed the anodes from the concrete. The photograph of the anodes taken from with and without BCPCIA concrete is shown in Fig 16.

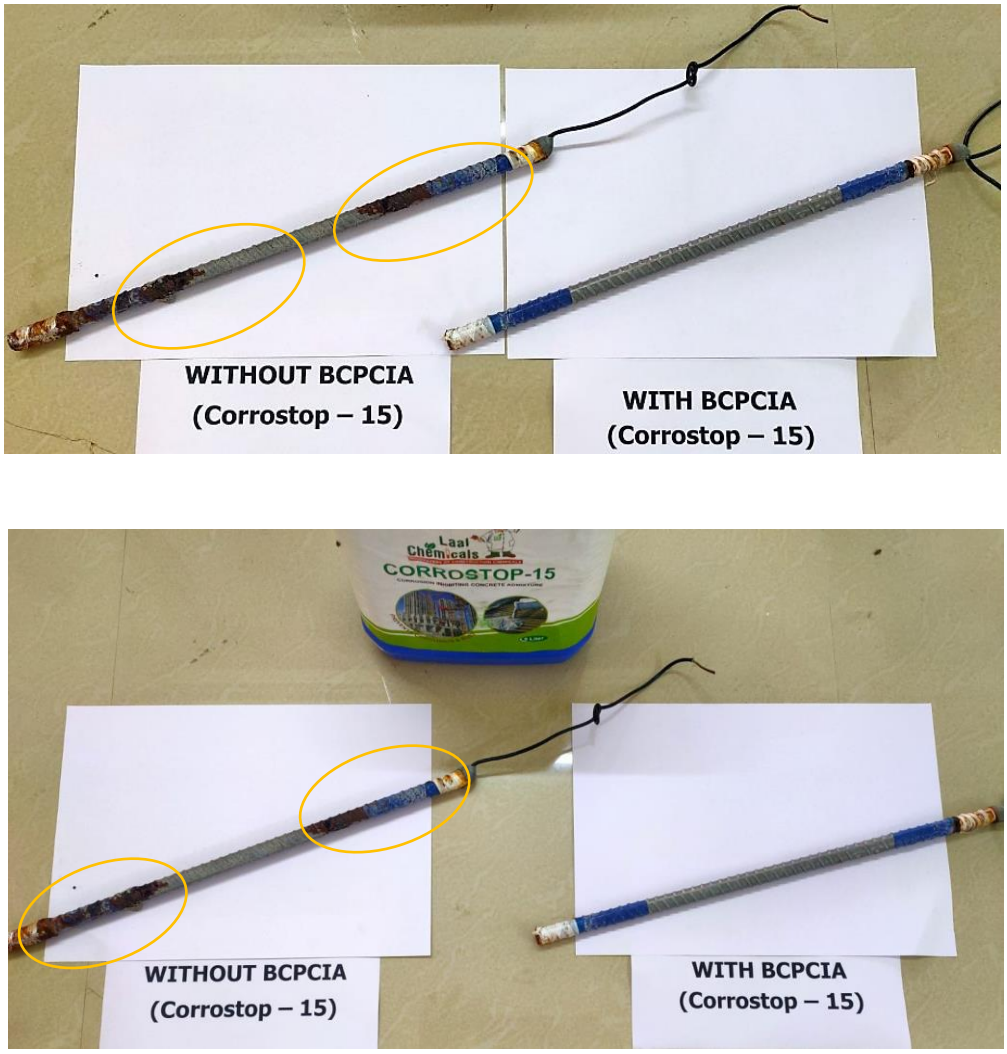

Fig. 16 Photographs of the rebar at the end of exposure (9th cycle)

Interestingly, it was noted from Fig. 16 that 50% of the steel rebar area was rusted in the case of without BCPCIA. On the other hand, no significant rusted area was noted in the case of 1% BCPCIA (Corrostop-15).

5. Conclusions and Recommendation

- The inhibitor (commercial name: Corrostop-15) supplied by the M/s. Laal Chemicals is evaluated for bipolar concrete penetrating corrosion inhibition for steel in concrete has passed all the short term and long term tests as per RDSO specification No. M&C/PCN/126/2020.
- The colour of the inhibitor is found ivory and no pungent smell was noted. No irritation on the skin when exposed to the inhibitor was also noted. These are the important characteristics for inhibitor suitable for construction purposes.
- The pH of the corrostop-15 was found to be 12.74. It is the fact that concrete pore solution having a pH of 12.5 to 13.0. This is quite suitable for our interest to use the Corrostop-15 is suitable for concrete.
- The specific gravity and viscosity of the Corrostop-15 inhibitor is well within the expected requirements as per the RDSO specification.
- **Modified accelerated corrosion test (based on Japanese Standard JIS Z – 1535) for 21 hours:** In raw water without BCPCIA showed excessive corrosion spots on the surface of the steel. On the other hand, raw water with BCPCIA showed very fewer corrosion spots on the surface of the steel. This satisfy the RDSO specification requirements.
- **Immersion test for 720 hours (rebar weight loss method) :** The average corrosion rate of rebar without and with BCPCIA was found to be 0.5152 mpy and 0.3074 mpy respectively. Here it was concluded that BCPCIA (Corrostop-15) performed better and act as a good inhibitor for the immersion test of 720 hours.
- **Effect of concrete admixture on compressive strength :** The compressive strength values for concrete without Corrostop-15 is 30 MPa. The addition of Corrostop-15 at 1% dosage level does not affect the compressive strength of the concrete. The addition of BCPCIA does not affect the compressive strength of concrete which is an essential and important requirements for the construction applications.
- **Polarization test by Tafel polarization with 3.5% NaCl for 20 days :** The corrosion rate of rebar without BCPCIA showed (1.7373 mpy) more when compared to the corrosion rate of steel rebar (0.1059 mpy) with BCPCIA (1% Corrostop -15). This data fulfils the expected requirements of BCPCIA in concrete as per RDSO specification.

- **Effect of BCPCIA on corrosion of embedded steel rebars exposed to chloride environments after 9 cycles (14 days wetting and 14 days drying) as per ASTM G109:**
    - The OCP of anodes in the concrete with Corrostop-15 lies in the passive region when compared to concrete without Corrostop-15. Hence, the probability of the corrosion of rebar in the system without BCPCIA is more when compared to system with BCPCIA.
    - The concrete admixed with 1% BCPCIA (Corrostop-15) effectively protected the rebar from corrosion and thereby reduced the macrocell current. The corrostop-15 performed better as bipolar corrosion inhibitor even in the very aggressive marine environment such as in 3.5% NaCl solution.
    - 50% of the steel rebar area were rusted in the case of without BCPCIA at the end of nine cycles of exposure. However, no significant rusted area was noted in the case of 1% BCPCIA (Corrostop-15).

Recommendation

- The inhibitor namely Corrostop-15 of M/s. Laal Chemicals, Chennai performed as a Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) in concrete.
- Corrostop-15 of M/s. Laal Chemicals, Chennai passed all the short term and long term test prescribed by RDSO specification number M & C / PCN /126 / 2020 (Revision 1.0)
- Hence, it is recommended to use Corrostop-15 of M/s. Laal Chemicals, Chennai as BCPCIA in concrete structures.

---- End of the report----

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Summary of Report

Project Title: Evaluation of **Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA)** to protect the embedded steel in concrete from corrosion

Sponsored Project Number: SSP 23/22

Objective: The objectives of the project is to evaluate the bipolar inhibiting nature of CORROSTOP-15 of M/s. Laal Chemicals, Chennai.

Test Results:

- The Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (BCPCIA) is tested in both short term and long term tests as per the RDSO specification No. M&C/PCN/126/2020 (Rev.1.0) and ASTM G109.
- The short term test for CORROSTOP-15 passed all the requirements as per RDSO specification M&C/PCN/126/2020 (Rev.1.0)
- The colour of CORROSTOP-15 looks very clear, smell is not pungent, no skin irritation and pH is 12.74 and viscosity is 11.38 sec. All the parameters are well within the limit of RDSO specification M&C/PCN/126/2020 (Rev.1.0)
- The corrosion rate of rebar with 1% CORROSTOP-15 is less than 2 mpy which perfectly passed the RDSO requirements through the long term immersion test of 720 hours.

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CSIR-CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद् Council of Scientific & Industrial Research)
कारैकुडी-630 003, तमिलनाडु, भारत Karaikudi-630 003, Tamil Nadu, India

- The concrete strength with 1% CORROSTOP-15 is greater than or equal to control concrete. This is must essential requirements for any inhibitor use in concrete. The mechanical properties of concrete is not affected when adding CORROSTOP-15 in concrete
- The electrochemical test by Tafel polarization in 3.5% NaCl solution for 20 days proved beyond doubt that CORROSTOP-15 follows the bipolar mechanism and act as a bipolar concrete penetrating corrosion inhibitor.
- Modified accelerated corrosion test (based on Japanese Standard JIS Z 1535) for 21 hours in raw water with BCPCIA showed only 1-2 corrosion spots.
- Macro cell corrosion studies of rebars in chloride environment passed upto 04 cycles (1 cycle consists of 14 days drying and 14 days wetting).
- CORROSTOP-15 supplied by Laal Chemicals showed better performance for protection of steel in reinforced concrete due to the bipolar mechanism.

The test results are satisfactory and meets the requirements as per standard tests held at CSIR-CECRI.

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