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Original Research Article

Concrete Resistivity and Corrosion Potential Probability Measurement of Reinforced Concrete Structures using Electrochemical Methods

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Abstract

Deterioration of reinforced concrete structures in marine environments is typically related to external retailers inclusive of chlorides that penetrate concrete causing harm. Corrosion products are relatively porous, susceptible, and often form around reinforcing metal, accordingly decreasing the bond between the reinforcement and concrete. This study evaluated the effect of using an extruded obtained from Perseus americana obtained from tree trunks as an inhibitor against corrosion attack on reinforced concrete structures in coastal zones with high salt concentrations and aggravated conditions. The extracted exudates/resin was coated to reinforcing steel and embedded in a concrete slab which is exposed to a corrosive medium with a high salt concentration The results of half-cell potential measurements maximum yields of the controlled and coated samples were -103.73 mV and -108.61mV, which showed the relationship between corrosion potential and probability in the Ecorr > 200mV as reference range. The potential results from Ecorr show that the value of the controlled and resin-coated sample with a 90% probability of no corrosion on reinforcing steel observed during the measurement is low (10% risk of corrosion, i.e. an average of 10% for the sample without coating gets the maximum value of -336.54mV, the result lies in the correlation reference value between the corrosion potential value of $-350\text{mV} \leq E\text{corr} \leq -200\text{mV}$, indicating a high-value range of 10% or indicating corrosion uncertainty. Comparatively, the results from the reference range (controlled) indicate that the sample is corroded due to the induced corrosion acceleration relative to the coated sample that the exudates/resin exhibits inhibitory properties against corrosion attack on reinforcing steel embedded in a concentrated re-plate which is exposed to a corrosive medium by forming a resistive layer. The maximum computed percentile of the controlled sample concrete resistivity is 66.23% compared to the corroded and coated values of -41.71% and 76.82% and the maximum controlled differential percentile is 2.71% compared to the corroded and coated value of 1.74 % and 5.28%. The results of the controlled and layered concrete resistance samples obtained the maximum average values of 15.2 kΩcm and 16.21 kΩcm with data values of 10 $<\rho$ <20 (low) compared to the corrosion value of 9.21 kΩcm with Specifications 5 $<\rho$ <10 (high) and with the reference range of the relationship between concrete resistance and corrosion probability, the corrosion probability was significant (ρ < 5, 5 < < 10, 10 << 20, > 20) for very high, high, low to moderate and low, for possible corrosion. From the comparative of coated and corroded samples, the maximum value obtained in both samples clearly shows the value of the coated sample with a range of 10 < 20, which classifies the range of values from low to moderate, with a significant indication of the possibility of corrosion. The maximum value of the corroded sample is in the range of 5 <10 which indicates high, signs indicating the presence of corrosion probability. The computed maximum percentile values of the controlled yield strength are 8.75% against corroded and the coated value of 7.2% and 8.81%, respectively, and the possible differential values are 0.05% controlled 0.89% corroded and 1.05 % coated. The controlled tensile strength is 2.885% compared to the corroded and coated values - 3.168% and 2.828% and the possible differential values are 0.19% controlled, 0.077% corroded and 0.039% coated. The comparative results show that the low load carrying capacity is caused by the effect of corrosion attack on the uncoated (corroded) elements, which damage the reinforcing steel fibers, ribs, and passive formation and surface modification. The maximum value computed from the percentile coated 0.049% against corroded -0.975% and 1.992%, the percentile differential in corroded 0.023% against coated 0.054%. For comparative, the results of the corroded samples showed reduction and reduction values compared to the diameter of the reinforcement before and after the induction accelerated corrosion test with a percentile range to reduce the value from 0.049% to -0.975% and the average value in the range of 11.95 mm to 11. 91 mm. The aggregate results show that the corrosion effect causes a reduction in weight/weight reduction in the corroded samples compared to coatings with a percentile exposure and an average increase, resulting in a small increase in the volume of the coating thickness.

Keywords: Corrosion, Corrosion inhibitors, corrosion potential, concrete resistivity, and Steel Reinforcement.

1.0 INTRODUCTION

The climatic conditions of an area have a great influence on the corrosion rate of reinforcing steel embedded in reinforced concrete structures that are exposed to a harsh and severe corrosive environment. In extreme climatic conditions in coastal regions, the rate of corrosion is always high. An instance is the Coastal region of Niger Delta; Nigeria has an extremely aggressive environment, characterized by high ambient temperature and humidity conditions, severe ground salinity with high levels of chlorides, and sulfates in the groundwater. Other factors accelerating the rate of corrosion are the poor quality of construction materials, particularly the aggregates, and the presence of high concentrations of sulfate salts in the service environment. Deterioration of reinforced concrete structures in marine environments is typically related to external retailers inclusive of chlorides that penetrate concrete causing harm. Corrosion products are relatively porous, susceptible, and often form around reinforcing metal, accordingly decreasing the bond between the reinforcement and concrete [1]. Also, corrosion reduces the cross-sectional region/area of metallic reinforcement, reducing the ductility of the structure, in particular when pitting corrosion happens. Corrosion inhibitors are widely used to delay corrosion of reinforcing metallic in concrete. They are chemical materials delivered to cement which when properly used, are powerful in retarding the corrosion of reinforcing metal in concrete [2-4]. Some inhibitors including chromates and benzoates have been proven [5, 6] to reduce the corrosion fee of steel bars; however, the introduction of inorganic less harmful and environmentally friendly inhibitors has proven to be retarders in curbing the scourge and harmful effects of corrosion to reinforcing steel.

Evaluated the extrusion viscosity of musanga cecropioides gum paste obtained from trees as an anti-corrosion material to slow down the effects of corrosion on steel rods embedded in concrete and constructed in high salinity coastal areas. The results of this potential Ecorr result show that the controlled sample value and low exudates/coated resin are low with a 90% probability that no corrosion of reinforcing steel is currently observed when measured (10% corrosion risk, which indicates a 10% or uncertain corrosion probability). For the uncoated sample, the maximum computed value obtained is -328.64mV, the result is in the range between the potential and the corrosion probability value $-350\text{mV} \leq E\text{corr} \leq -200\text{mV}$, which indicates a high value range of 10% or uncertain corrosion possibility. The comparative results from the reference range (controlled) show that the corroded samples showed corrosion as a result of the induced corrosion acceleration compared to the coated samples which showed no corrosion [7].

Evaluated the specter of corrosive effects on rebar using Calotropic procera exudates/resins applied directly to rebar embedded in concrete slabs and exposed to coastal brine in various thicknesses to limit the rate and extent of corrosion. The hardened concrete slab was completely immersed in 5% sodium chloride (NaCl) solution for 360 days, with regular inspection and inspection intervals after 90 days, 180 days, 270 days, and 360 days. The results compared with the reference range (controlled) indicated that the uncoated samples exhibited a higher corrosion potential due to the induced corrosion acceleration compared to the coated samples. The combined results show that the corrosion effect on the corroded samples causes a decrease in weight compared to coatings with percentile values and an increase in mean values, which causes a slight increase in volume with coating thickness [8].

Researched corrosion resistance, concrete formulations and rigorous testing of rust, corrosion and coated reinforced concrete cast elements. Direct application of corrosion inhibitor to edulis dacryodic resin with varying integrated thickness to 12mm diameter reinforcing steel, placed on a concrete slab and exposed to a corrosive medium for 119 days for accelerated corrosion test, half cell potential measurement, concrete resistance measurement and tensile test. Compared to the corroded sample, the corroded had a 70.1% increase in value and a 38.8% decrease in the resistance of the concrete, leading to a higher compressive strength [9].

Investigated electrochemical processes leading to electron transfer during the corrosion process of reinforcing steel in harsh marine environments with high chloride content. Corrosion tests were carried out on reinforced steel bars with a high strength of 12mm, the rough surface of the sample was treated with symphonia globulifera resin extract with different layer thicknesses, polished and embedded in a concrete slab. Control samples, non-inhibited samples, and resin-inhibited samples were cured for the first 28 days and the corrosion acceleration process with sodium chloride lasted 119 days with a verified reading interval of 14 days. Compared to the corroded sample, the corroded sample showed a 70.1% increase in the potential value of Ecorr, mV and a 38.8% decrease in the value of the concrete strength, tensile stress relative to the maximum force compared to corrosion due to a 100% increase in nominal strength 103 0, 06% to a reduction of 96.12% and a reduction in weight of 67.5% compared to 48.5% and a reduction of 47.80% to 94.82% of the cross-sectional diameter, both of which have reduced corrosion values compared to the sample from the exhibition cover image [10].

Demonstrated the effectiveness and effectiveness of exudates/resin as an inhibitor of corrosion effects on reinforcement embedded in concrete slab samples exposed to induced corrosion. The maximum yields of the controlled and coated samples were -108.04 mV and -122.85 mV, which indicated the relationship between corrosion potential and the reference probability $E\text{corr} > -200\text{mV}$ as the reference range. The result is in the reference value the relationship between corrosion potential and probability $-350\text{mV} \leq E\text{corr} \leq -200\text{mV}$ value, which indicates a high value range close to 10% or an uncertain corrosion probability compared to the reference range. The computed maximum percentile of controlled sample concrete was 141.67% compared to the corroded and coated values of -52.84% and 131.05%, and the differential in the maximum control percentile was 23.15% compared to the corroded and coated values. The results of the controlled and layered concrete resistance samples got a maximum mean value of 15.96 kΩcm and 15.47 kΩcm with a data value of 10 < ρ < 20 (low) compared to a corrosion value of 7.28 kΩcm with specifications (5 <ρ <10) and with the reference range of the relationship between concrete resistance and corrosion probability. The effect of corrosion attack on reinforcing steel embedded in the concrete slab and exposed to the acceleration effect caused by corrosion. The combined results show that the corrosion effect on the corroded sample causes a decrease/decrease in weight compared to coatings with a percentile load and an average increase, leading to a slight increase in the volume of the coating thickness [11].

Stated that concrete with 2 and 4% CN inhibitor-based totally on the weight of cement did no longer show any corrosion initiation after 122 days while concrete was immersed in NaCl solution, or exposed to seawater. In every other examination with reinforced concrete (w/c ratio = 0.50) exposed to 3.5% NaCl wetting/drying cycles for three years, 2.5% CN changed into prevailing in delaying corrosion initiation. However, in every other examine CN was only powerful in delaying corrosion but now not prevailing after the initiation of corrosion [12].

Reported that Acacia Gum is a good corrosion inhibitor in HCl and H2SO4 solutions for mild steel corrosion [13]. The results showed that the corrosion rate of MS in HCl and H2SO4 decreases with increasing concentrations of Gum Acacia. Weight loss, the evolution of hydrogen and polarization methods used to propose the potential application of Gum Acacia as a green corrosion inhibitor for mild steel in acidic media Acacia Gum also has been reported as inhibitors that are good for mild steel in H2SO4 solution with additives halide, and the results obtained show that the increase in the efficiency of inhibition with increased concentration of the inhibitor, and additives halides enhance the inhibitory effects and the mechanism is found to comply with the adsorption of Temkin isotherm [14]. Aluminum corrosion inhibition reported in alkaline solution with gum Arabic [15]. Corrosion inhibition of Al in NaOH in the presence of iodide ion Acacia Gum and studied using weight loss and hydrogen evolution techniques. The results showed that Acacia Gum inhibits Al corrosion in NaOH media with potassium halide additives and inhibition efficiency increases with increasing concentration and temperature. Adsorption Acacia Gum, KI and (GA + KI) follow the Temkin adsorption [16].

Investigated the effects of chloride attack on reinforcing steel embedded in reinforced concrete layers in a marine environment. Experimental work has measured the rapid process with an accelerated process of uncoated and inhibited Acardium occidental l., with a varying thickness, mounted on a concrete slab and immersed in sodium chloride and accelerated by 119 days according to the Wenner method by placing four directly connected concrete surfaces above the reinforcing steel line and evaluating the component cell bearing capacity, concrete size, and tensile strength and corrosion hardness. Compared to the corrosion samples, corrosion showed an increase in Ecorr, mV by 75.4% and a decrease in concrete resistance by 33.54% [17].

Reported that Locust bean candy gum is also known as carob gum and extracted from the seeds of the carob tree. It mainly consists of galactomannan-type polysaccharide with a galactose: mannose ratio of about 1: 4. LB rubber investigated for potential corrosion inhibition to carbon steel corrosion of steel marked 39, 44, and B500 in the solution H2SO4. The electrochemical and potentiodynamic polarization method used for testing inhibitory revealed that carob gum showed an inhibitory effect against Steel 39 in an acidic medium with the addition of NaCl [18].

Investigated the potential for estimating possible corrosion rates by measuring half-cell potential tests, concrete resistance tests and tensile tests, mechanical properties of un-corroded, corroded, and delayed reinforcement with moringa oleifera paste coating resin made from wood extract. The sample was immersed in concrete and accelerated in a corrosive environment for 119 days. The average percentile of Ecorr potential, mV, and concrete resistance is 29.9% and 68.74%, respectively. Compared to the corroded samples, the corroded samples showed a 70.1% increase in the E_{corr} potential value, mV, and a 35.5% decrease in the concrete resistance value. The results of the calculation of the average percentile of stress at the melting point versus corrosion, as the nominal yield point, decreased from 100% from 105.75% to 96.12% and weight loss was 67.5% compared to 48.5% and 48.34% to 94.82%, reduced in areas both of which had lower corrosion values compared to the coated samples [19].

2.1 MATERIALS AND METHODS

2.1.1 Aggregate

The fine and coarse (aggregates) are obtained from the sand dump sites and they met the requirements of [20].

2.1.2. Cement

Grade 42.5 limestone cement was purchased from the market and used for all mixes. The cement meets the requirements of [21].

2.1.3. Water

The water samples were taken from the laboratory of the Department of Civil Engineering, Kenule Beeson Saro-Wiwa Polytechnic, Bori, Rivers. The water meets the requirements of [22].

2.1.4 Structural steel reinforcements

The reinforcing steel was purchased directly from the market in Port Harcourt and met [23].

2.1.5 Corrosion Inhibitors (Resins / Exudates) Persea americana mill

The gum exudates were extracted from the tree bark by tapping. The tree is abundantly planted in Nigeria. Exudates were gotten from Oyigba Village in Ahoada –West Local Government Area of Rivers state

2.2 Experimental procedure

2.2.1 Experimental method

2.2.2 Preparation of exudate/resin coating reinforced sample

This study examines the effect of using an extruded thick paste made from Perseus americana obtained from tree trunks, as an inhibitor against corrosion attack on reinforced concrete structures in coastal zones with high salt concentrations and aggravated conditions. The extracted exudates/resin slurry is coated in reinforced steel and embedded in a concrete slab which is exposed to a corrosive medium with a high salt concentration. The process of corrosion behavior is long-term. However, the artificial introduction of sodium chloride (NaCl) accelerates the corrosion rate, and its properties appear in a very short time. The effect of corrosion rate and breakdown damage is measured by estimating the current density from the polarization curve or by measuring the corrosion rate. The plates used in this study were made in batches based on the weight of the material using a manual mixing process with a standard concrete ratio of 1.2.4 and a water to cement ratio of 0.65. The modeled concrete slab has a size of 100 mm × 500 mm × 500 mm (thickness, width, and length), is poured into a metal mold, compressed to an empty state and zero air, and reinforced with 10 steel bars with a diameter of 12 mm and set to 100 mm c/c (upper and lower), unchanged after 72 hours and cured at normal room temperature for 28 days to set. The hardened concrete slab is then completely immersed in 5% sodium chloride (NaCl) solution and accelerated for 360 days with accelerated induced corrosion and routinely for 90 days, 180 days, 270 days, and 360 days inspection and -Testing to determine sample performance uncoated and coated.

2.3 Accelerated corrosion test

Corrosion is a long-term process, but the rapid induction and accelerated corrosion process induced with sodium chloride (NaCl) solution causes corrosion of steel bars embedded in concrete and can accelerate corrosion for days. To test the corrosion resistance of concrete, experimental methods were developed to accelerate the corrosion process and maximize the corrosion resistance of concrete. The accelerated corrosion test is an impressed method; it is an effective method for checking the corrosion process of steel in concrete and evaluating the protective layer of concrete for steel reinforcement. Accelerated corrosion tests are carried out for structure and corrosion resistance of components as well as for the selection of suitable materials and suitable protective systems to obtain quantitative and qualitative statements about corrosion.

2.4 Corrosion Current Measurement (Half Cell Potential Measurement)

The classification of the corrosion severity of reinforcing steel is shown in Table 2.1. If potential measurements indicate a high probability of active corrosion, the degree of corrosion can be assessed by measuring the resistance of the concrete. However, caution should be exercised when using these data, as the corrosion rate is assumed to be constant over time. This is also proven by practical experience (Figg and Marsden [24], Gower and Millard [25]). Half-cell measurement is an indirect method of estimating the probability of corrosion. Recently there has been great interest in the development of instruments for the measurement of electrochemical disturbances in the steel itself to obtain direct estimates of corrosion rates (Stem and Geary [26]). Corrosion rates are related to electrochemical measurements, the first of which is based on data.

Table 2.1: Dependence between potential and corrosion probability [27]

Potential E_{corr}	**Probability of Corrosion**
$E\text{corr} < -350\text{mV}$	Greater than 90% probability that reinforcing steel corrosion is occurring in that area at the time of measurement
$-350\text{mV} \leq E\text{c}_{orr} \leq -200\text{mV}$	Corrosion activity of the reinforcing steel in that area is uncertain
$E_{corr} > -200\text{mV}$	90% probability that no reinforcing steel corrosion is occurring in that area at the time of measurement (10% risk of corrosion

2.5 Tests used to Measure the Electrical Resistivity of Concrete

Different measured values are measured at different points on the concrete surface. After water is applied to the surface of the slab, the resistance of the concrete is measured daily at a reference point to determine its saturation status. The reason for choosing this position is that water can be placed on top of the panel to measure resistance specifically. The saturation of the slab is controlled by measuring the resistance of the concrete, which is directly related to the moisture content of the concrete. Once one plate is saturated, the water flows while the other plate remains closed. The time constraint is the greatest challenge in all experimental measurements, as the saturation state of the concrete changes over time. In addition, the four probes are in direct contact with the reinforced concrete of the rail. Because each slab has a different water to cement ratio, the time it takes to soak each slab will be different. Before applying water to the floor, measure the resistance of the concrete at certain points when it dries. After the concrete reaches saturation, the resistance remains constant

Table 2.2: Dependence between Concrete Resistivity and Corrosion Probability [28]

Concrete resistivity ρ, kΩcm	**Probability of corrosion**
$\rho < 5$	Very high
$5 < \rho < 10$	High
$10 < \rho < 20$	Low to moderate
$\rho > 20$	Low

2.6 The tensile strength of Bars

The test determines the yield point and the maximum point of tensile strength of steel bars. The reinforced concrete slab was reinforced with 10 steel bars with a diameter of 12 mm (top and bottom) to evaluate the behavior of coated and uncoated steel with induced corrosion. The Universal Testing Machine (UTM) is subjected to a pressure test to check the damage of the samples for a comparative evaluation of their properties. To ensure stability, the remaining pieces are used for the diameter of the steel bar before the test, the diameter of the steel bar after corrosion, the decrease/increase in the cross-sectional area after corrosion, the weight of the steel bar (before testing), the weight of the Steel bar (check other weight loss parameters after corrosion)

3.0 TEST RESULTS AND DISCUSSION

For a simpler explanation, please plot the half-cell potential measurement results in Table 1 with the resistance in Table 3. Used to represent the probability of severe to very high, very high, and very low to moderate and very low probability of corrosion (ρ20). At other measurement points, the probability of correction is high (–350 mV≤Ecorr≤ - 200 mV), indicating that the probability of corrosion is 10% or uncertain. It has been proven that with a low corrosion potential in a certain range (<-350mV) the probability of corrosion is 95%. Resistivity research data indicates whether certain states can help reduce ion movement, leading to increased corrosion.

Table 3.1: Potential E_{corr}, after 28 days curing and 360days Accelerated Periods of Control Concrete slab Specimens

	Control Concrete slab Specimens											
Sample Numbers	PAMS	PAMS1	PAMS2	PAMS3	PAMS4	PAMS5	PAMS6	PAMS7	PAMS8	PAMS9	PAMS 10	PAMS 11
	Time Intervals after 28 days curing											
Sampling and Durations	**Samples 1 (28 days)**			**Samples 2 (28 Days)**			**Samples 3 (28 Days)**			**Samples 4 (28 Days)**		
Potential Ecorr, mV	-105.2	-108.8	-104.3	-103.3	-105.5	-102.1	-110.6	-106.4	-102.9	-104.5	-108.9	-102.6
Concrete Resistivity ρ, kΩcm	15.07	15.07	15.06	15.05	15.05	15.21	15.21	15.20	15.19	15.19	15.13	15.05
Yield Strength, fy (MPa)	456.44	459.44	455.44	455.74	456.44	455.67	458.67	458.97	457.67	459.06	455.57	459.40
Ultimate Tensile Strength, fu (MPa)	625.16	623.11	624.79	620.57	624.10	624.52	624.32	625.12	623.72	625.27	624.77	624.63
Strain Ratio	1.37	1.36	1.37	1.36	1.37	1.37	1.36	1.36	1.36	1.36	1.37	1.36
Rebar Diameter Before Test (mm)	11.96	11.94	11.95	11.96	11.94	11.96	11.96	11.94	11.94	11.94	11.94	11.95
Rebar Diameter at 28 days(mm)	11.96	11.94	11.95	11.96	11.94	11.96	11.96	11.94	11.94	11.94	11.94	11.95
Cross- Sectional Area Reduction/Increase (Diameter, mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rebar Weights- Before Test	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89
Rebar Weights- After at 28 days (Kg)	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89
Weight Loss /Gain of Steel (Kg) at 28 days	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.2: Potential Ecorr, after 28 days curing and 360days Accelerated Periods of Corroded Concrete slab Specimens

Sampling and Durations	Samples 1 (90 days)			Samples 2 (180 Days)			Samples 3 (270 Days)				Samples 4 (360 Days)	
Potential Ecorr, mV	-334.1	-339.3	-336.2	-328.6	-338.4	-345.4	-379.3	-386.5	-390.6	-393.2	-397.9	-396.5
Concrete Resistivity ρ, kΩcm	8.82	9.00	9.83	8.83	9.61	9.17	8.79	9.34	9.38	8.98	9.15	9.16
Yield Strength, fy (MPa)	419.77	422.77	418.77	419.07	419.77	419.00	422.00	422.30	421.00	422.39	418.90	422.73
Ultimate Tensile Strength, fu (MPa)	618.63	616.58	618.26	614.04	617.57	617.99	617.79	618.59	617.19	618.74	618.24	618.10
Strain Ratio	1.47	1.46	1.48	1.47	1.47	1.47	1.46	1.46	1.47	1.46	1.48	1.46
Rebar Diameter Before Test (mm)	11.96	11.94	11.95	11.96	11.94	11.96	11.96	11.94	11.95	11.95	11.94	11.95
Rebar Diameter- After Corrosion(mm)	11.91	11.90	11.91	11.91	11.90	11.92	11.92	11.90	11.90	11.90	11.90	11.91
Cross- ectional Area Reduction/Increase (Diameter, mm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Rebar Weights- Before Test (Kg)	0.88	0.89	0.89	0.88	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89
Rebar Weights- After Corrosion (Kg)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Weight Loss /Gain of Steel (Kg)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.05

Table 3.3: Potential Ecorr, after 28 days curing and 360days Accelerated Periods of Persea americana mill Exudate / Resin Coated Specimens

Sampling and Durations	Samples 1 (90 days)			Samples 2 (180 Days)			Samples 3 (270 Days)			Samples 4 (360 Days)		
	150µm (Exudate/Resin) coated			300µm (Exudate/Resin) coated			450µm (Exudate/Resin) coated			600µm (Exudate/Resin) coated		
Potential Ecorr, mV	-110.1	-112.9	-112.5	-112.6	-108.9	-113.6	-111.2	-115.2	-111.6	-106.2	-106.9	-112.4
Concrete Resistivity ρ, kΩcm	15.61	15.76	16.04	16.17	15.86	16.15	16.10	16.25	16.28	15.75	15.64	15.49
Yield Strength, fy (MPa)	456.05	456.05	456.35	456.05	457.28	455.28	452.58	455.28	455.67	456.18	455.01	454.72
Ultimate Tensile Strength, fu (MPa)	620.56	618.51	620.19	615.97	619.50	619.92	619.72	620.52	619.12	620.67	620.17	620.03
Strain Ratio	1.36	1.36	1.36	1.35	1.36	1.36	1.37	1.36	1.36	1.36	1.36	1.36
Rebar Diameter Before Test (mm)	11.97	11.95	11.96	11.97	11.95	11.97	11.97	11.95	11.95	11.95	11.95	11.96
Rebar Diameter- After Corrosion(mm)	12.03	12.01	12.02	12.03	12.01	12.03	12.03	12.01	12.01	12.01	12.01	12.02
Cross- Sectional Area Reduction/Increase (Diameter, mm)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Rebar Weights- Before Test (Kg)	0.89	0.89	0.89	0.88	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89
Rebar Weights- After Corrosion (Kg)	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Weight Loss /Gain of Steel (Kg)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07

Table 3.4: Average Potential Ecorr, after 28 days curing and 360days Accelerated Periods (Control, Corroded and Exudates/Resin Coated (specimens Average Potential E_{corr}, after 28 days curing and 360 days

Sampling and Durations	**Control Concrete slab Specimens**				**Corroded Concrete slab Specimens**				**Persea americana Exudate / Resin Coated Specimens**			
	Average Potential Ecorr, Values of Control Concrete slab Specimens				Average Potential Ecorr, Values of Corroded Concrete slab Specimens				Average Potential Ecorr, Values of Persea americana mill Exudate / Resin Coated Specimens			
Potential Ecorr, mV	-106.1	-103.7	-106.6	-105.2	-336.5	-337.4	-385.7	-395.9	-111.6	-111.5	-112.6	-108.1
Concrete Resistivity ρ, kΩcm	15.07	15.10	15.20	15.12	9.21	9.21	9.17	9.10	15.80	16.06	16.21	15.63
Yield Strength, fy (MPa)	457.11	455.95	458.44	458.01	420.44	419.28	421.77	421.34	456.15	456.20	454.51	455.30
Ultimate Tensile Strength, fu (MPa)	624.35	623.06	624.38	624.89	617.82	616.53	617.85	618.36	619.75	618.46	619.78	620.29
Strain Ratio	1.37	1.37	1.36	1.36	1.47	1.47	1.47	1.47	1.36	1.36	1.36	1.36
Rebar Diameter Before Test (mm)	11.95	11.95	11.95	11.94	11.95	11.96	11.95	11.95	11.96	11.96	11.96	11.95
Rebar Diameter- After Corrosion(mm)	11.95	11.95	11.95	11.94	11.91	11.91	11.90	11.90	12.02	12.02	12.01	12.01
Cross- Sectional Area Reduction/Increase (Diameter, mm)	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
Rebar Weights- Before Test (Kg)	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Rebar Weights- After Corrosion (Kg)	0.89	0.89	0.89	0.89	0.83	0.83	0.83	0.83	0.96	0.96	0.96	0.96
Weight Loss /Gain of Steel (Kg)	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.06	0.07	0.07	0.07	0.07

Table 3.5: Average Percentile Potential Ecorr, after 28 days curing and 360days Accelerated Periods (Control, Corroded and Exudate/Resin Coated (specimens)

	Control Concrete slab Specimens				**Corroded Concrete slab Specimens**				**Persea americana Exudate / Resin Coated Specimens**			
	Percentile Average Potential Ecorr, Values of Control Concrete slab Specimens				Percentile Average Potential Ecorr, Values of Corroded Concrete slab Specimens				Percentile Average Potential Ecorr, Values of Persea americana mill Exudate / Resin Coated Specimens			
Potential Ecorr, mV	-68.46	-69.26	-72.35	-73.43	200.86	202.59	242.25	264.56	-66.76	-66.95	-70.78	-72.57
Concrete Resistivity ρ, kΩcm	63.52	64.07	65.77	66.23	-41.71	-42.69	-43.45	-41.80	71.54	74.48	76.82	71.81
Yield Strength, fy (MPAM) %	8.72	8.75	8.70	8.70	-7.83	-8.09	-7.20	-7.46	8.50	8.81	7.76	8.06
Ultimate strength (MPa)	2.705	2.695	2.792	2.885	-3.245	-3.168	-3.233	-3.245	2.815	2.828	2.795	2.789
Strain Ratio	-7.08	-7.01	-7.03	-7.08	8.17	8.41	7.41	7.70	-7.55	-7.76	-6.89	-7.15
Rebar Diameter Before Test (mm)	0.446	0.446	0.449	0.445	0.447	0.444	0.449	0.445	0.445	0.448	0.446	0.448
Rebar Diameter- After Corrosion(mm)	0.466	0.467	0.493	0.462	-0.992	-0.998	-0.975	-0.984	1.962	1.938	1.992	1.986
Cross- Sectional Area Reduction/Increase (Diameter, mm)	0.00	0.00	0.00	0.00	-14.04	-15.79	-15.79	-15.79	16.33	18.75	18.75	18.75
Rebar Weights- Before Test (Kg)	0.405	0.408	0.406	0.407	0.401	0.410	0.406	0.410	0.408	0.406	0.405	0.408
Rebar Weights- After Corrosion (Kg)	9.78	9.52	9.68	9.62	-13.26	-13.15	-13.14	-13.26	12.28	12.14	12.13	12.28
Weight Loss /Gain of Steel (Kg)	0.00	0.00	0.00	0.00	-25.00	-27.40	-25.00	-24.66	33.33	37.74	33.33	32.73

3.1 Results of Potential E_{corr}, mV, and Concrete Resistivity ρ, kΩcm on Concrete Slab Members

The electrical resistivity of concrete is an important parameter to describe the durability of concrete structures and the risk of corrosion in reinforcement [29-32]. In addition, this property is very important for the design of electrochemical repair systems and for monitoring repair efficiency. The corrosion rate is controlled by the ease with which ions can pass through the concrete from the cathode to the anode region. Large potential gradients with low concrete resistance therefore usually lead to high corrosion values, depending on the moisture content of the concrete, type of cement used, water/cement ratio (w/c), presence of chloride ions and carbonization of concrete status [29, 33]. The most commonly used field test technique is Wenner's 4 probes sample technique [34, 35]. The probe is placed on the surface of the tested concrete and an alternating current is changed between the two outer electrodes, while the voltage is recorded at the two inner electrodes. The disadvantage of this technique is that the conduction pathway may not be known with certainty. The measurement of concrete resistance is influenced by several parameters that can negatively affect the determination of the formation factor. The most important factors are moisture content and temperature; increasing one of the two increases ion transport in the pore solution and reduces the resistance of concrete [36-40]. The corrosion E_{corr}mV potential results, and concrete resistance, kΩcm, are obtained from Tables 3.1-3.3 and are summarized in Tables 3.4 and 3.5 against the mean and percentile values plotted graphically in Figure 3.1-3.8b the results of controlled, uncoated (corroded) and coated samples for 36 concrete slabs, divided into 3 sets, 12 controlled samples, which are the determining reference range, 12 samples uncoated (corroded) and 12 samples with exudates/resin coated.

The mean and minimum, maximum, and differential values of the half-cell potential measurements computed from the controlled sample were -106.6 mV and -103.73 mV (-73.43% and -68.46%) with potential differentials (2.87mV and 4.97%), the corroded samples were -395.93mV and -336.54mV having percentile values of (200.86% and 264.56%) and the differential values were 59.39mV and 63.7% and the coated samples were -112.63mV and -108.6mV and percentile data values of (-72.57% and -66.76%) and the potential differential is 4.02 mV and 5.81%, respectively. The computed maximum control percentile value is -68.46% compared to the corroded and closed values of 264.56% and 66.76% and the controlled potential differential value is 4.97%, corroded 63.7% and closed 5.81%. The results of half-cell potential measurements maximum yields of the controlled and coated samples were -103.73 mV and -108.61mV, which showed the relationship between corrosion potential and probability in the E_{corr} > 200mV as reference range. The potential results from Ecorr show that the value of the controlled and resin-coated sample with a 90% probability of no corrosion on reinforcing steel observed during the measurement is low (10% risk of corrosion, i.e. an average of 10% for the sample without coating gets the maximum value of -336.54mV, the result lies in the correlation reference value between the corrosion potential value of -350mV $\leq E$corr ≤ -200mV, indicating a high value range of 10% or indicating corrosion uncertainty. Comparatively, the results from the reference range (controlled) indicate that the sample is corroded due to the induced corrosion acceleration relative to the coated sample that the exudates/resin exhibits inhibitory properties against corrosion attack on reinforcing steel embedded in a concentrated re-plate which is exposed to a corrosive medium by forming a resistive layer.

The average value and the minimum and maximum percentile of concrete resistance with controlled sample potential differential are 15.07 kΩcm and 15.2 kΩcm (63.52% and 66.23%) and the differential value is 0.13 kΩcm and 2.71%. Corroded samples were 9.1 kΩcm and 9.21kΩcm (-43.45% and -41.71%) and the differential values were 0.11 kΩcm and 1.74%, coated samples were 15.63kΩcm and 16.21 kΩcm (71.54% and 76.82%) and the differential values of 0.58 mV and 5.28%. The maximum computed percentile of the controlled sample concrete resistivity is 66.23% compared to the corroded and coated values of -41.71% and 76.82% and the maximum controlled differential percentile are 2.71% compared to the corroded and coated value of 1.74 % and 5.28%. The results of the controlled and layered concrete resistance samples obtained the maximum average values of 15.2 kΩcm and 16.21 kΩcm with data values of $10 < \rho < 20$ (low) compared to the corrosion value of 9.21 kΩcm with Specifications $5 < \rho < 10$ (high) and with the reference range of the relationship between concrete resistance and corrosion probability, the corrosion probability was significant (ρ < 5, 5 < < 10, 10 < 20, > 20) for very high, high, low to moderate and low, for possible corrosion. From the comparative of coated and corroded samples, the maximum value obtained in both samples clearly shows the value of the coated sample with a range of 10 < 20, which classifies the range of values from low to moderate, with a significant indication of the possibility of corrosion. The maximum value of the corroded sample is in the range of 5 <10 which indicates high, signs indicating the presence of corrosion probability, as validated in the studies of [8, 9, 7, 11, 10, 17]. From the results obtained, it can be compared that the effect of corrosion attack was observed in uncoated samples, while samples with exudates / resins with corrosion protection properties with highly resistant and water-resistant membranes that prevent corrosion of the embedded reinforcing steel in concrete and exposed induced accelerated corrosion media.

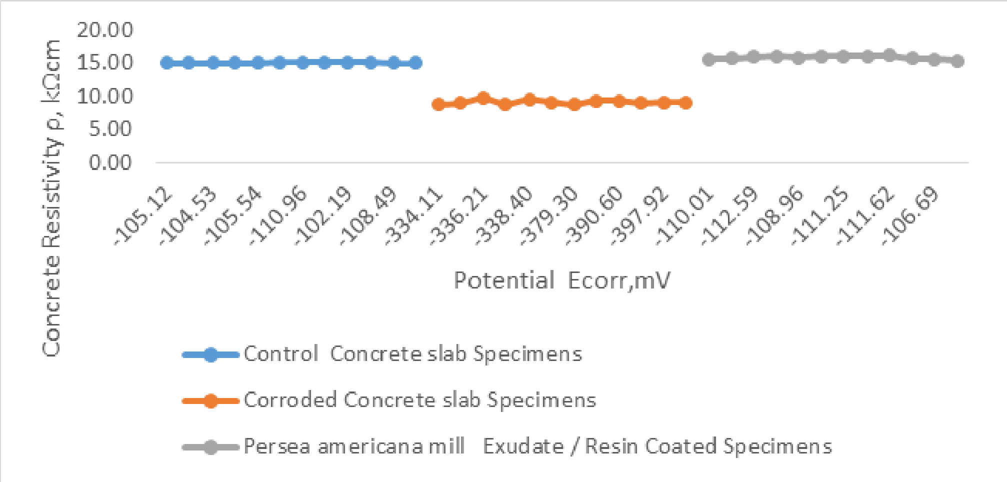

Figure 3.1: Concrete Resistivity ρ, kΩcm versus Potential Ecorr, mV Relationship

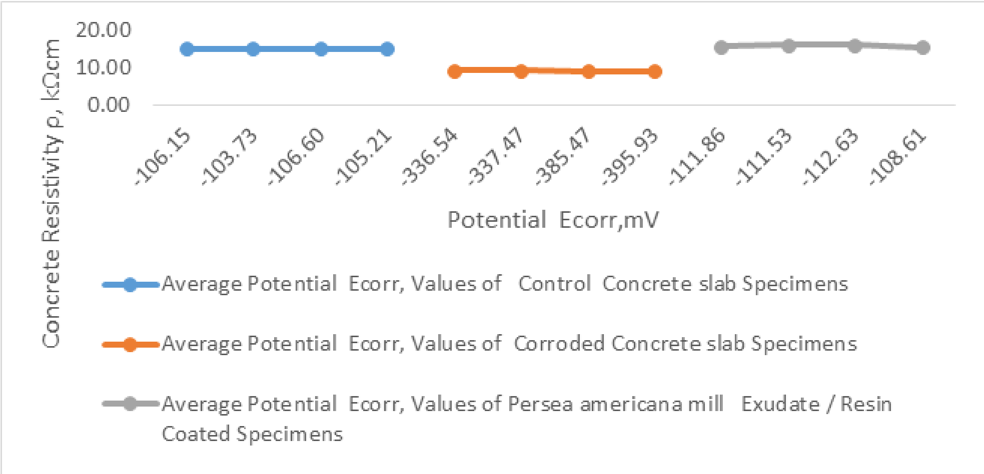

Figure 3.1A: Concrete Resistivity ρ, kΩcm versus Potential Ecorr, mV Relationship

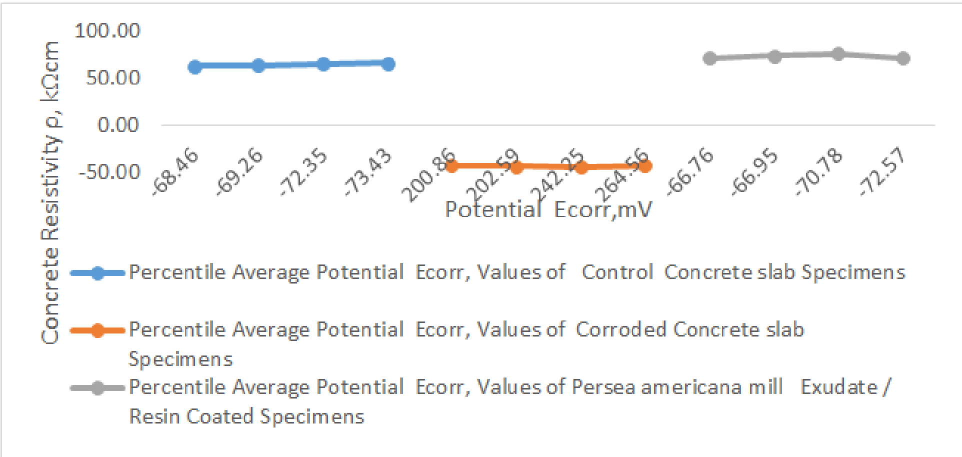

Figure 3.1B: Average Percentile Concrete Resistivity versus Potential Relationship

3.2 Results of Mechanical Properties of Yield Strength, Ultimate Strength and Strain Ratio of Embedded Reinforcing Steel in Concrete Slab

The steel-concrete interface is the most important part of the structure in determining the corrosion mechanism and the corrosion rate of steel reinforcement [41-43]. The installation of steel in concrete is intended to protect steel from corrosion. In fact, in the alkaline environment of the pore solution, a passive film spontaneously forms on the steel surface during the first days/weeks of exposure [44-46]. The role of steel reinforcement is to improve the mechanical properties of the structure because it provides tensile strength, ductility and crack resistance [47]. Various types of fittings can be used, such as carbon steel, epoxy coated steel, galvanized steel, stainless steel, and various alloy steels. Ribbed reinforcement is commonly used in reinforced concrete structures to provide a strong and cohesive bond between steel and concrete.

The results of the mean, percentile, and the differential in the minimum and maximum yield strength, fy (MPa) of the controlled sample were 455.95MPa and 458.44MPa (8.7% and 8.75%), and the differential value was 2.49 MPa and 0.05%, the corroded samples were 419.28MPa and 421.77 MPa (-8.09% and -7.2%) and the differential values were 2.49 MPa and 0.89%, the coated sample values were 454.51MPa and 456.2MPa (7.76% and 8.81%) and the differential value is 1.69 MPa and 1.05%. The computed maximum percentile values of the controlled yield strength is 8.75% against corroded and the coated value of 7.2% and 8.81%, respectively, and the possible differential values are 0.05% controlled 0.89% corroded and 1.05 % coated. The mean, percentile and differential in the minimum and maximum tensile strength, fu (MPa) of the controlled samples were 623.06 MPa and 624.89MPa (2.695% and 2.885%) and the differential values were 1.83 MPa and 0.19%, respectively. Corroded is 616.53MPa and 618.36MPa (-3,245 MPa and -3.168%) and the differential is 1.83 MPa and 0.077%, the coated is 618.46MPa and 620.29MPa (2.789% and 2.828%) and the differential values of (1.83MPa and 0.039%). The controlled tensile strength is 2.885% compared to the corroded and coated values - 3.168% and 2.828% and the possible differential values are 0.19% controlled, 0.077% corroded and 0.039% coated.

The minimum and maximum mean, percent and deformation values of the controlled sample are 1.36 and 1.37 (-7.08% and -7.01%) with a differential value of 0.01 and 0.07%, the sample is corroded 1 .47 and 1.47 (7.41 and 8.41%) and the differential values of 0.00 and 1.0%, the coated samples were 1.36 and 1.36 (-7.76% and -6.89%) and the differential value of 0.00 and 0.87%. % and -6.89% coverage and differential peak controlled 0.07%, 1.0% corroded and 0.87% coated, as validated in the studies of [8, 9, 7, 11, 10, 17]. The computed results, which are summarized in Tables 3.4 and 3.5 and shown graphically represented in Figures 3.1-3.8, were used to determine the yield strength, tensile strength and strain ratio of the mean, percentile and differential potential values of the control, uncoated (corroded) and samples of coated concrete slabs, coated samples showed higher failure loads compared to corroded samples with reduced breaking loads and low load bearing capacity and with average values and percentages to the reference range, while uncoated (corroded) low loads - carrying capacity and reduced value compared to the reference range. The comparative results show that the low load carrying capacity is caused by the effect of corrosion attack on the uncoated (corroded) elements, which damage the reinforcing steel fibers, ribs and passive formation and surface modification. The preservation value of the coated samples in both is due to the potential for resistance when corrosion penetrates the reinforcing steel with the formation of a protective membrane; these attributes indicate the effectiveness and effectiveness of the exudates/resin as an inhibitor against corrosive effects of reinforced concrete structures, heavy coastal areas with high exposed salinity.

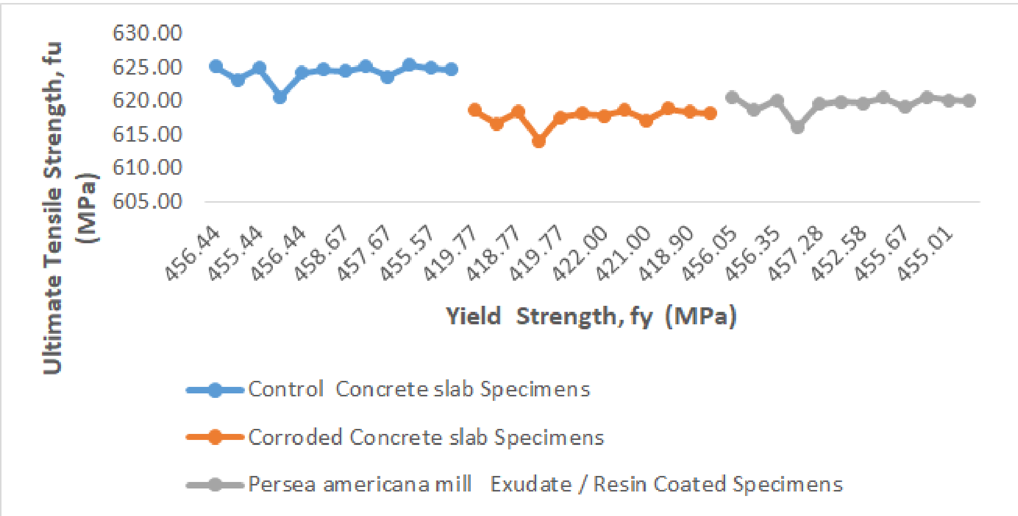

Figure 3.2: Yield Strength versus Ultimate strength

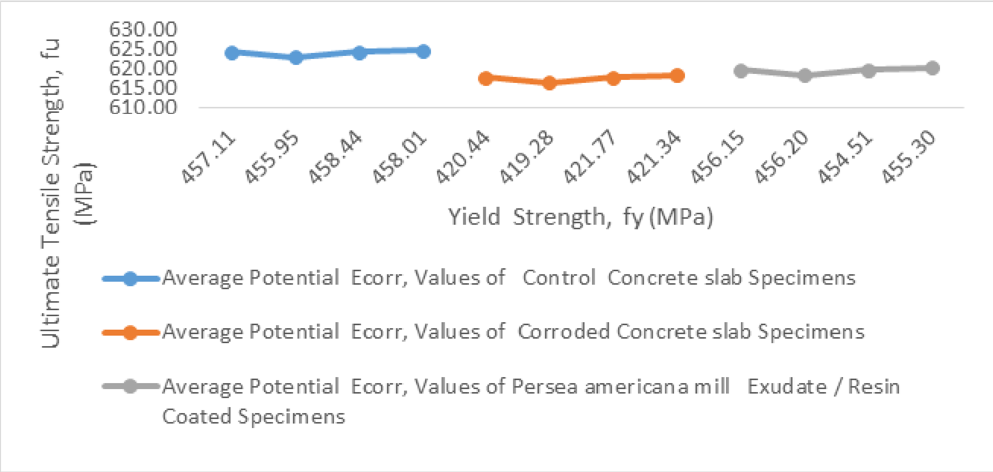

Figure 3.2A: Yield Strength versus Ultimate strength

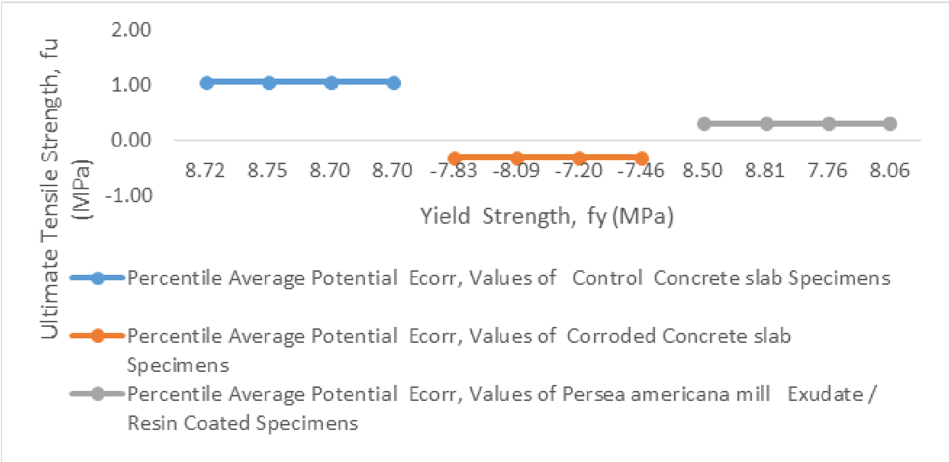

Figure 3.2B: Average Percentile Yield Strength versus Ultimate Tensile Strength

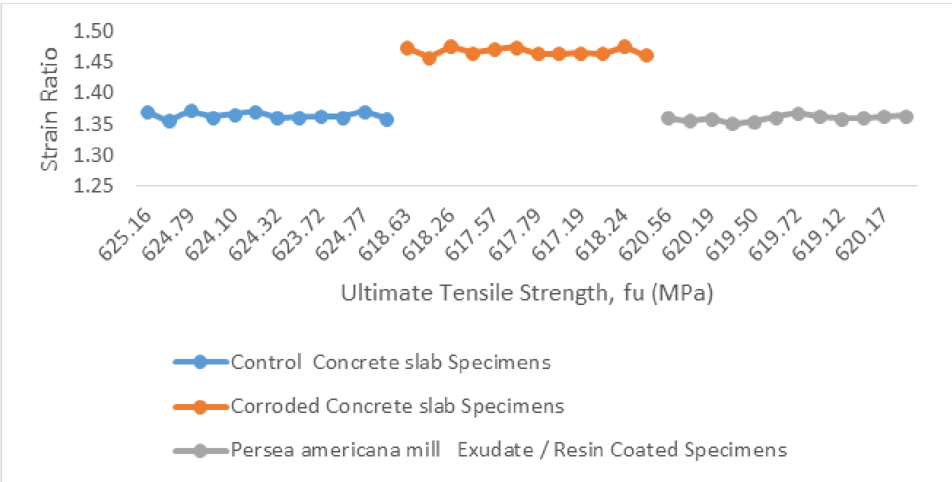

Figure 3.3: Ultimate Tensile Strength ersus Strain Ratio

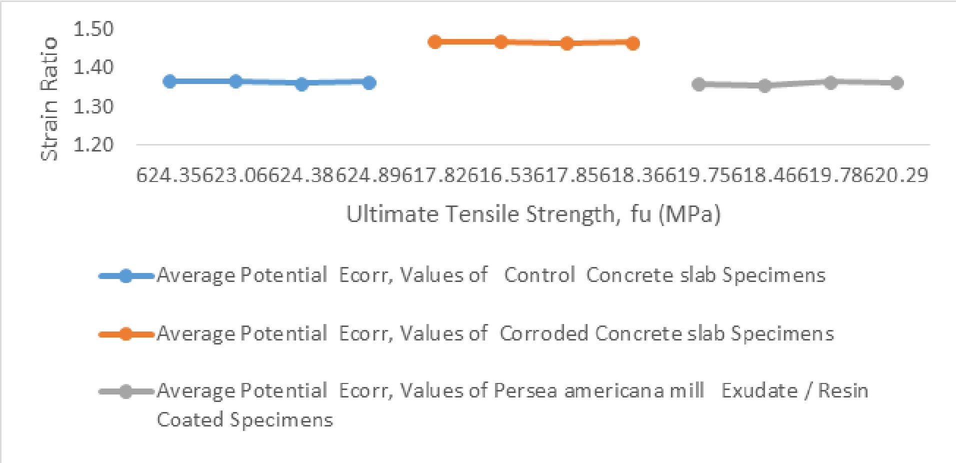

Figure 3.3A: Average Ultimate Tensile Strength versus Strain Ratio

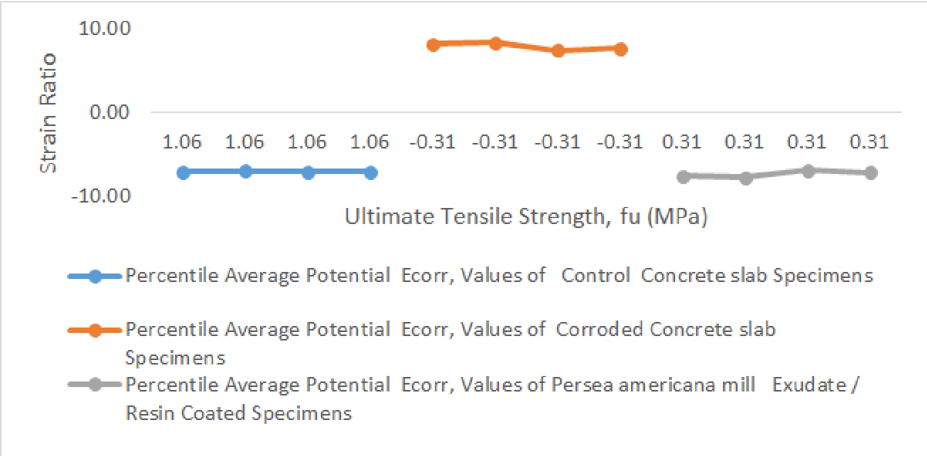

Figure 3.3B: Average percentile Ultimate Tensile Strength versus Strain Ratio

3.3 Results of Mechanical Properties of Rebar Diameter, Cross -Sectional Area and Weight Loss / Increase of Embedded Reinforcing Steel in Concrete Slab

The corrosion of reinforcing steel alters some of the main parameters used in the construction of structures, and its frequency leads to several significant consequences, for example: loss of cross-sectional area of reinforcement; increased radial tensile forces in the concrete - with subsequent cracking of the roof due to rust on the surface of the reinforcement and the surrounding aerated concrete structure - which ultimately leads to further concreting; and loss of connection between concrete and reinforcement. The mechanical properties of corroded reinforced concrete structures depend on the cross section, the size of the reinforcement area and the corrosion rate. The active cross-section of the steel decreases in proportion to the corrosion rate, as the mechanical properties change. Corrosion of reinforcing steel is one of the most significant types of damage to reinforced concrete structures, especially structures exposed to the marine environment [48-50]. Corrosion affects the structural integrity of the concrete structure and causes a decrease in the mechanical properties of steel reinforcement [51, 52]. The significantly worsening effect of corrosion is the reduction of the usable cross-sectional area of the reinforcing structural elements [53, 54]. The loss of cross-sectional area of steel is the destruction of steel to its original state, namely rust. The initiation and propagation phases are the two main stages which involve the formation of corrosion. So far, corrosion causes a reduction in the area of steel reinforcement and affects its dynamic and static behavior or mechanical behavior [55].

The diameter of the reinforcing steel before testing (mm) the minimum and maximum average and percentile values were controlled 11.94 mm and 11.95 mm (0.045% and 0.049%) with a differential value of 0.01 mm and 0.004%, the corroded sample was 11. 95 mm and 11.96 mm (0.044% and 0.049%) and the differential values of 0.01 mm and 0.005%, and the values of the coated samples were 11.95 mm and 11.96 mm (0.045% and 0.048%) and computed differential, values of 0.01 mm and 0.003%. The weight of rebar before the corrosion test shows a negligible differential values due to the product and shape resulting from various production firms by-products used in the production process. The mean, percentile and differential in diameter of reinforcement after corrosion (mm) minimum and maximum obtained for the controlled sample were 11.94 mm and 11.95 mm (0.045% and 0.049%) with a differential of 0.01 mm and 0.004%, maintaining the reference value is 100%, the corroded sample values are 11.9 mm and 11.91 mm (-0.998% and -0.975%) and the differential is 0.01 mm and 0.023%, the coated Sample values are 12.01 mm and 12.02 mm (1.938% and 1.922%) and the differential between 0.01 mm and 0.054%. The maximum value computed from the percentile coated 0.049% against corroded -0.975% and 1.992%, the percentile differential in corroded 0.023% against coated 0.054%. The results obtained in Tables 3.4 and 3.5, which are summarized in Tables 3.1, 3.2 and 3.3 and shown graphically in Figures 3.3-3.6b, shows the effect of corrosion attack on reinforcing steel embedded in the concrete slab, which is exposed to induced corrosion-accelerating activity. For comparative, the results of the corroded samples showed reduction and reduction values compared to the diameter of the reinforcement before and after the induction accelerated corrosion test with a percentile range to reduce the value from 0.049% to -0.975% and the average value in the range of 11.95 mm to 11. 91 mm.

The decrease/increase (diameter) in the cross section of the minimum and maximum mean and percentile values was controlled 100%, with no decrease or increase in the description after 360 days of immersion in fresh water. Corroded sample values were 0.05mm and 0.05mm (-15.79% and -14.04%) and the differential in corrosion was 0.00% and 1.75%, the values of the coated samples were 0.06 mm and 0.06 mm (16.33% and 18.75%) and the differential was 0.00 mm and 2.42 %. The relative mean and differential in percentile values between coated and corroded samples ranged from 18.75% to -14.04%. The decrease in mean and percentile values indicates that the corrosion effect causes a reduction in diameter and cross-sectional area, fiber degradation, rib reduction and surface modification, whereas exudates/resin-coated elements cause an increase in volume due to different thicknesses coatings as reported in works of [8, 9, 7, 11, 10, 17].

In summary, it can be said that the exudates/resin has inhibitory properties against corrosive effects on reinforcing steel embedded in the concrete slab sample, which is induced in a high salinity environment. Weight of rebar - before testing (kg), the mean and minimum, maximum and differential percentiles of the controlled samples were 0.89kg and 0.89kg (9.52% and 9.78%), and a differential of 0.00% and 0.26%, the samples of corroded are 0.89kg and 0.89kg (9.75% and 9.75%), and the differential was 0.00% and 0.00%, the samples of coated are 0.89 kg and 0.89 kg (6.76% and 6.76%) with a differential of 0.00% and 0.00%.

The results of the average and percentile of reinforcement weight after corrosion (Kg) and the generalized differential value of the minimum and maximum values of the controlled samples were 0.89kg and 0.89kg (9.52% and 9.78%), and the differential was 0.00% and 0.26%, the samples of corroded 0.83kg and 0.83kg (-13.26% and -13.14%) and the differential of 0.00% and 0.12%, the value of the coated sample was 0.96kg and 0.96kg (12.13% and 12.28%) and the differential between 0.00% and 0.15%.

The mean and percentile loss/gain of the minimum and maximum weight of steel (kg) and the percentile differential in the comparative is controlled by the value maintained at 100% as a result of aggregation in fresh water tanks with no trace of corrosion potential against the corrosion value of the 0.05 kg sample and 0.06kg (-27.4% and -24.66%) and 0.07kg and 0.07kg, the coated are (32.73% and 37.74%). The computed results obtained from Tables 3.1-3.3 and summarized in 3.4-3.5 and shown graphically in Figure 3.7-3.8 show the effect of corrosion on uncoated (corroded) and coated steel and check the weight of the pieces of reinforcement before and after the corrosion and weight gain. Comparative results obtained showed a decrease and increase in mean and percentile values with 0.07kg coated to 0.05kg and 37.74% to -24.66% corroded, as validated in the studies of [8, 9, 7, 11, 10, 17]. The aggregate results show that the corrosion effect causes a reduction in weight/weight reduction in the corroded samples compared to coatings with a percentile exposure and an average increase, resulting in a small increase in the volume of the coating thickness. This study shows the effectiveness and efficiency of exudates/resin as an inhibitor against the effects of corrosion on reinforcement embedded in samples of concrete slabs exposed to induced corrosion.

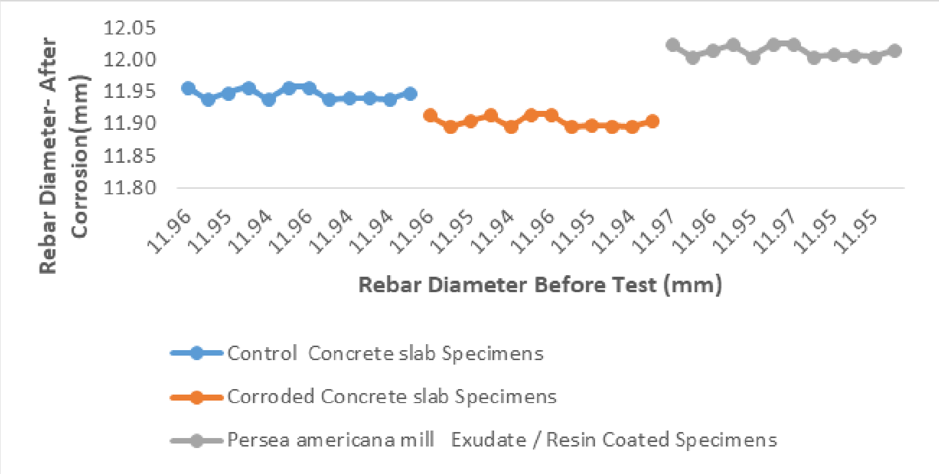

Figure 3.4: Rebar Diameter before Test (mm) versus Rebar Diameter- After Corrosion (mm)

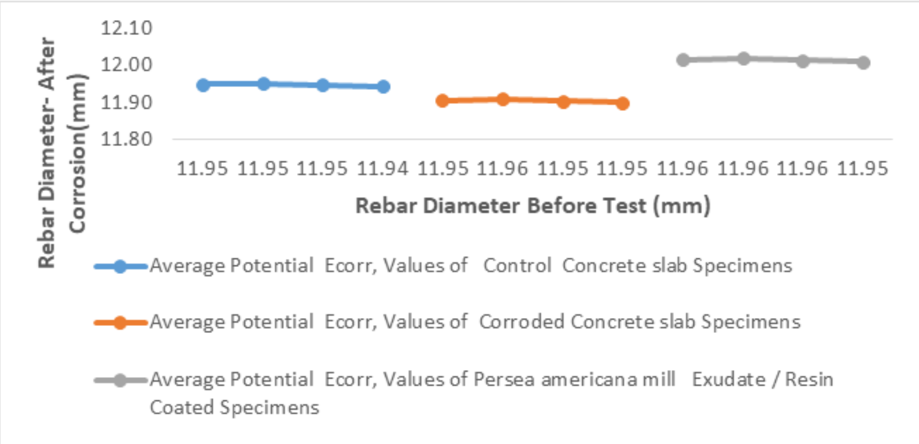

Figure 3.4A: Average Rebar Diameter before Test (mm) versus Rebar Diameter- After Corrosion (mm)

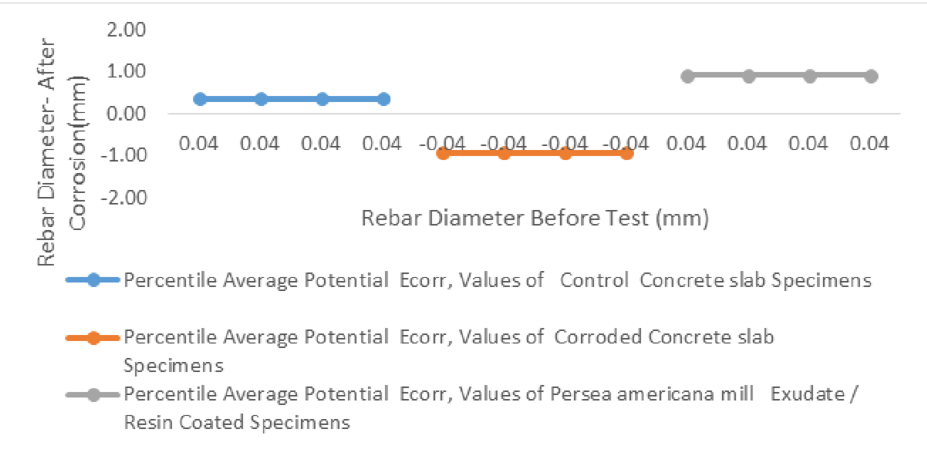

Figure 3.4B: Average Percentile Rebar Diameter before Test (mm) versus Rebar Diameter- After Corrosion (mm)

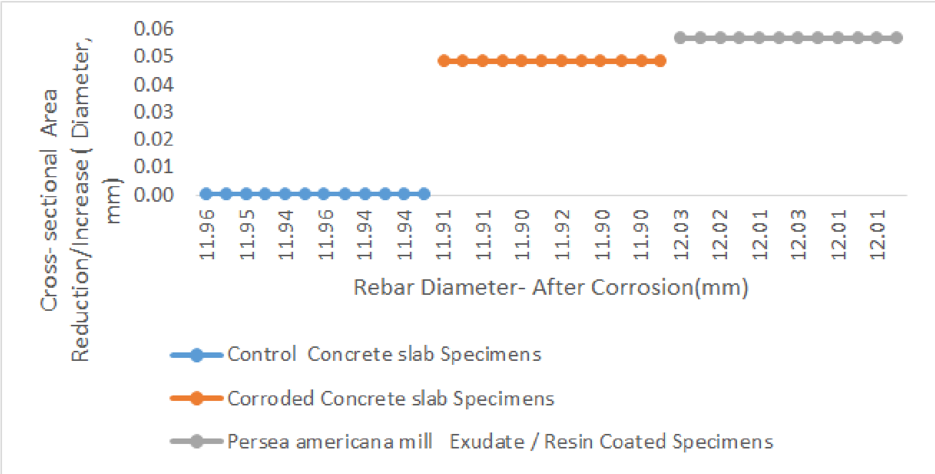

Figure 3.5: Rebar Diameter- after Corrosion (mm) versus Cross- section Area Reduction/Increase (Diameter, mm)

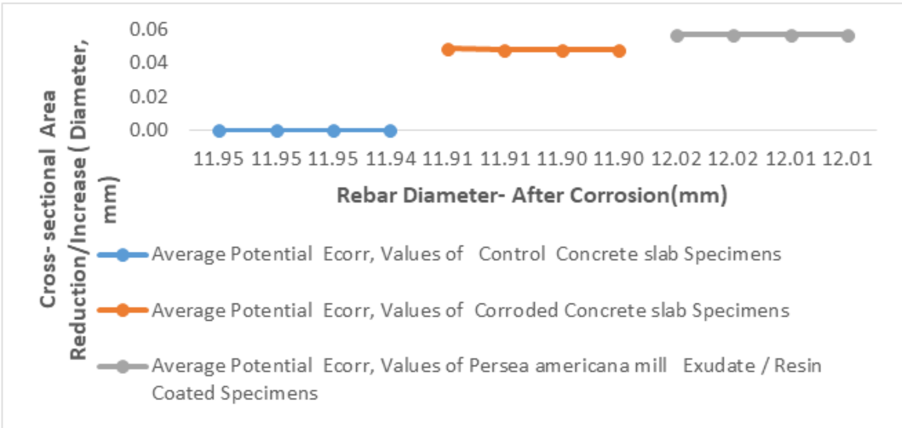

Figure 3.5A: Average Rebar Diameter- after Corrosion (mm) versus Cross- section Area Reduction/Increase (Diameter, mm)

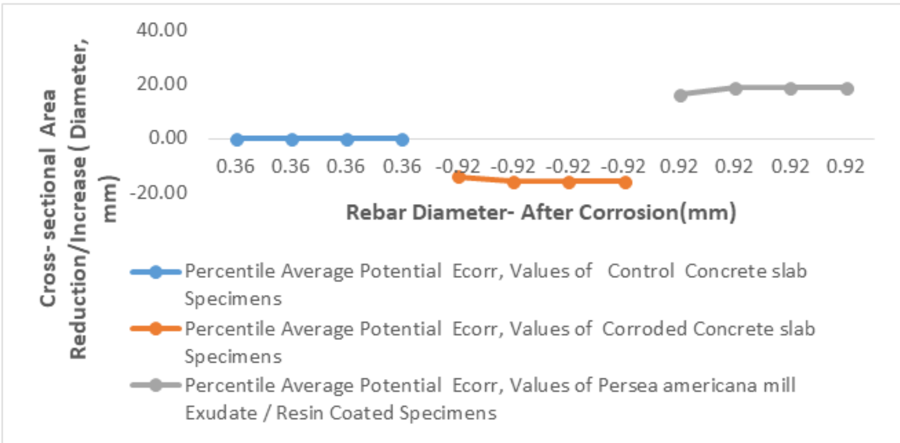

Figure 3.5B: Average Percentile Rebar Diameter- after Corrosion (mm) versus Cross- section Area Reduction/Increase (Diameter, mm)

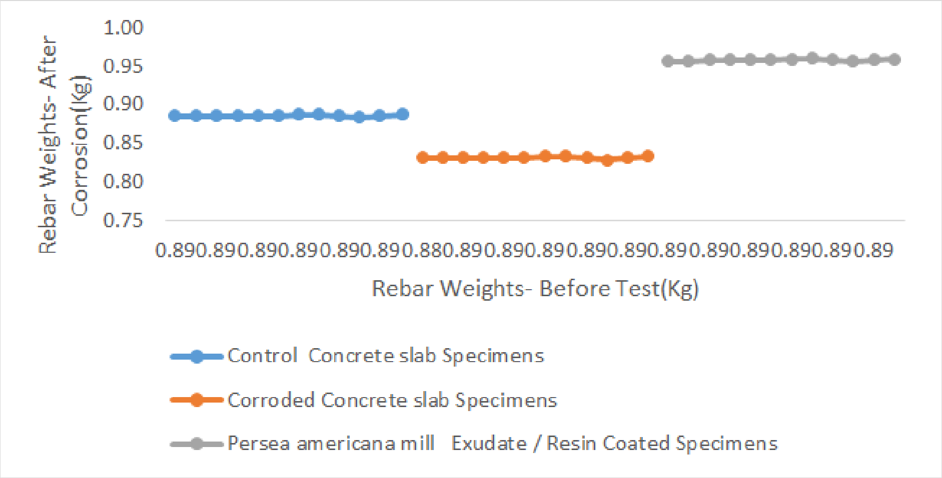

Figure 3.6: Rebar Diameter - After Corrosion (mm) versus Cross- section Area Reduction/Increase (Diameter, mm)

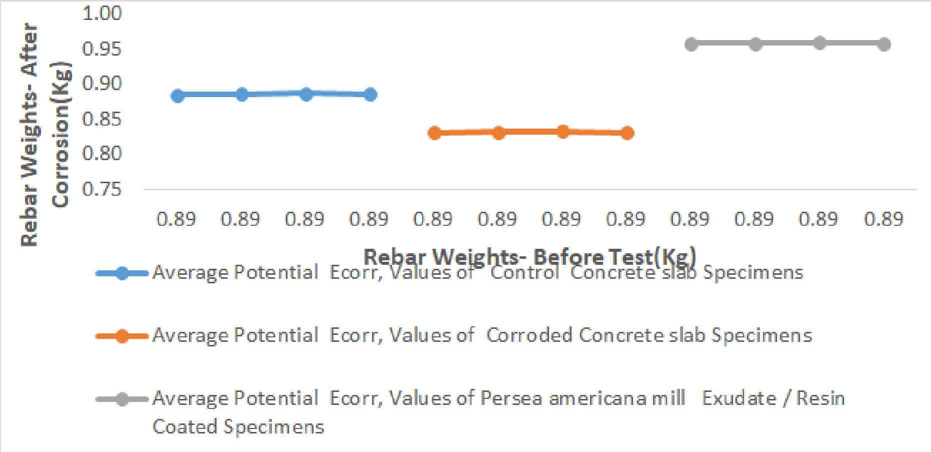

Figure 3.6A: Average Rebar Diameter - After Corrosion (mm) versus Cross- section Area Reduction/Increase (Diameter, mm

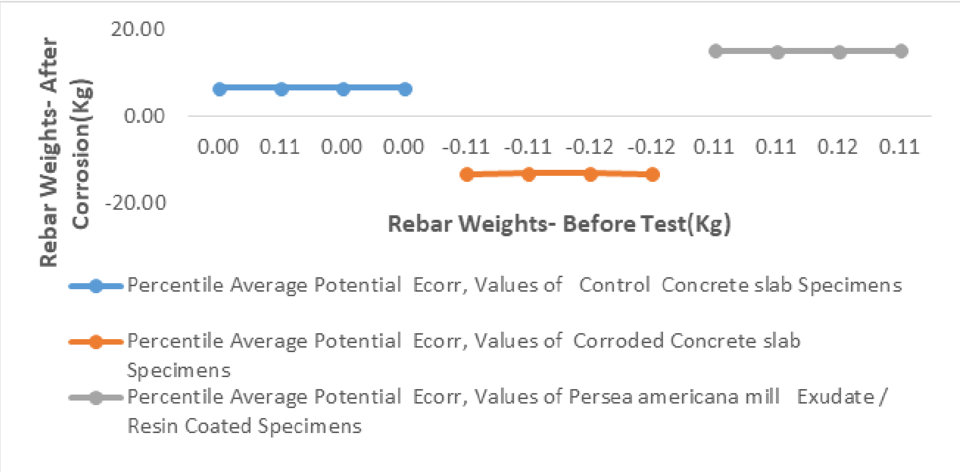

Figure 3.6B: Average Percentile Rebar Diameter - After Corrosion (mm) versus Cross- section Area Reduction/Increase (Diameter, mm)

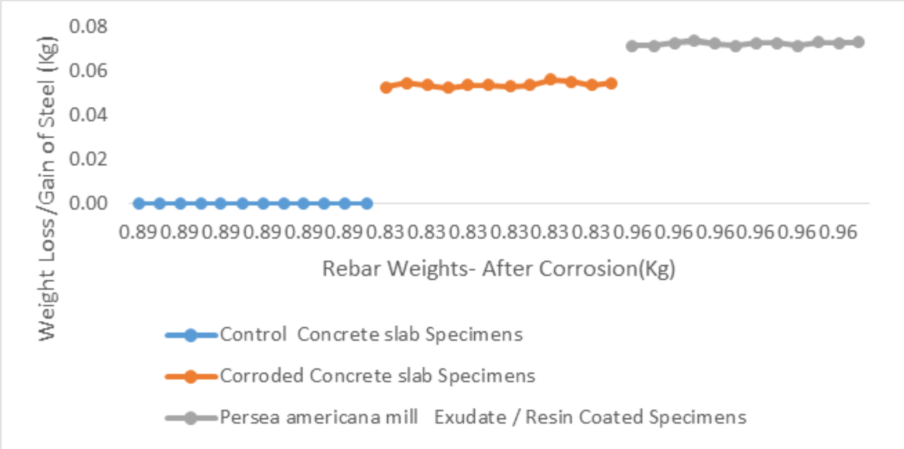

Figure 3.7: Rebar Weights- After Corrosion (Kg) versus Weight Loss /Gain of Steel (Kg)

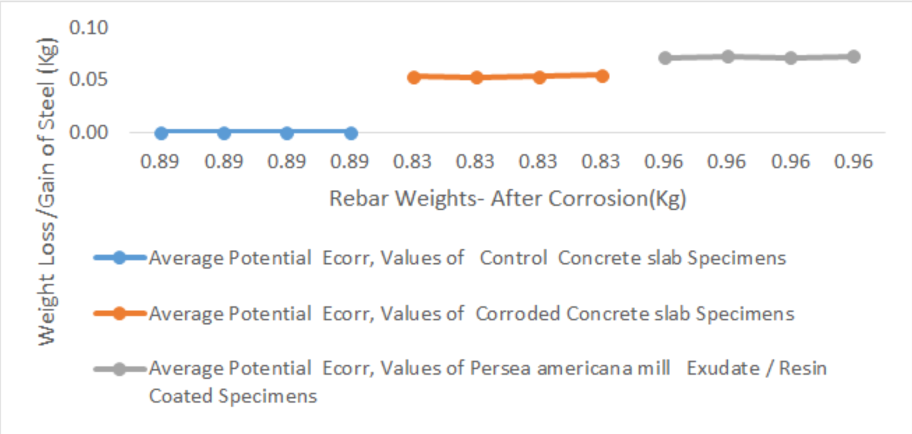

Figure 3.7A: Average Rebar Weights- After Corrosion (Kg) versus Weight Loss /Gain of Steel (Kg)

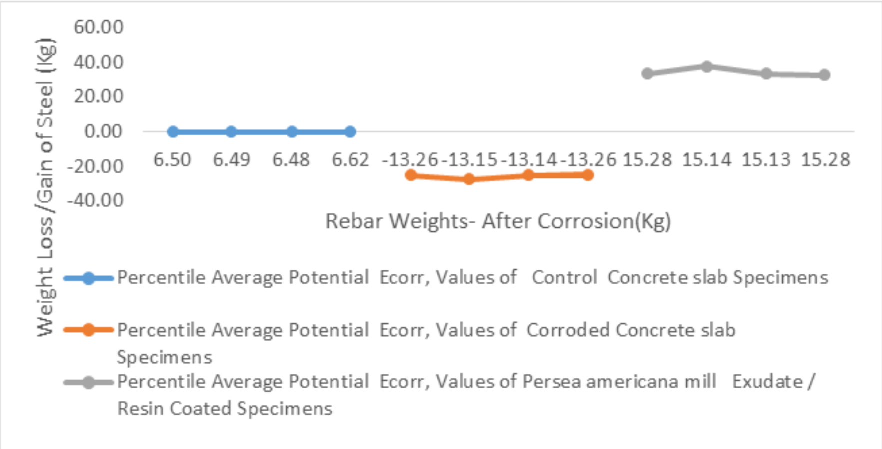

Figure 3.7B: Average Percentile Rebar Weights- After Corrosion (Kg) versus Weight Loss /Gain of Steel (Kg)

4.0 CONCLUSION

The experimental results show the following conclusions:

1. Uncoated samples showed higher corrosion potential values as a result of accelerated corrosion, which was caused by coated samples showing no corrosion and did not attack reinforcing steel embedded in concrete slabs and exposed to highly corrosive saline media.
2. The coated sample exhibits inhibitory properties with the formation of a layer that is resistant to the spread of corrosion.
3. The effect of corrosion attack was observed in uncoated samples, whereas exudates/resin coated samples had anti-corrosion properties with highly

resistant and water-resistant membranes that prevented corrosion of reinforcing steel embedded in concrete structures exposed to high salinity due to induction.

4. Corroded samples show high yield strength at low loads, which indicates the effect of corrosion on the mechanical properties of reinforcing steel, which causes low load bearing capacity, corroded also shows a higher coefficient of deformation compared to coatings in the above parameters.
5. The results obtained indicate that the coated samples maintain a closed range of values compared to the controlled samples, which has the property that the samples with exudate/resin coating have the potential to inhibit corrosive attack on the reinforcing steel embedded in them. concrete structures and exposed corrosive membrane forming media. waterproof and durable.

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