Flexural Strength of Non-coated and Coated Reinforcement Embedded in Concrete Beam and pooled in Corrosive Solution

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***Abstract*—Corrosion of reinforcing steel embedded in concrete results to degradation and loss of structural strength of reinforcing steel which in turns has led to untimely collapse of many structures exposed to marine coastal environments with severe weather. This research work examined the mechanical properties of surface changes, diameter reduction and weight loss of reinforcing steel of non- corroded, non-coated and exudates / resins coated members in an aggressive environment. Non-coated and coated members with varying thicknesses were embedded in concrete structures and exposed for given period of 150 days and monitored. Results of corroded member flexural failure load obtained from average percentile value are -35.965% against 56.167% and 57.226% non-corroded and exudates coated specimens. Midspan deflection average percentile of 82.017% against -45.060% and -53.492% non-corroded and coated specimens. Average yield strength is 100% with 0.00% of percentile value. Ultimate tensile strength average percentile value -13.7955% against 16.003% and 15.913% of non-corroded and coated specimens. Strain ratio average percentile value of -12.368% against 14.114% and 13.433% of non-corroded and coated specimens. Elongations average percentile value of -47.220% against 89.4675% and 91.378% for non-corroded and coated specimens. Corroded members summarized results showed reduction in mechanical properties of reinforcing steel due to corrosion attack which has resulted to high yield with low load application, high midspan deflection and elongation, while coated members maintained high structural integrity. Summarized results of non-corroded over corroded specimens showed that non-corroded (controlled) samples superseded corroded samples properties in low flexural failure, low midspan – deflection, normal yield strength, high ultimate strength, low strain ratio. Coated members showed high flexural load before failure occurrence as compared to corroded members with low load to high yields and elongation.**

Keywords—Corrosion, Corrosion inhibitors, Flexural Strength, Concrete and Steel Reinforcement

1. INTRODUCTION

Effects of corrosion on reinforcing steel in reinforced concrete structures lead to decrease in the bar diameter, deterioration of the mechanical properties of the reinforcing steel (e.g., the change from the normal ductile response of low carbon steel bars to a relatively brittle response in bars damaged by pitting, cracking and spalling of the concrete and noticeable decrease in the bond at the steel-concrete interface. Cracks can reduce the overall strength and stiffness of the concrete structure and accelerate the ingress of aggressive ions, leading to other types of concrete deterioration and resulting in further cracking [1]. The use of organic compounds to inhibit corrosion of mild steel and iron has assumed great significance due to their application in preventing corrosion under various corrosive environments [2]. The development of corrosion inhibitors is based on organic compounds containing nitrogen, oxygen, sulfur atoms and multiple bonds in the molecules that facilitate adsorption on the metal surface [3]. Plant extracts are viewed as an incredibly rich source of naturally synthesized chemical compounds that can be extracted by simple procedures with low cost and are biodegradable in nature. The use of these natural products such as extracted compounds from leaves or seeds as corrosion inhibitors have been widely reported by several authors ([4], [5], [6], [7], 8], [9], Ismail, [10], [11], [12], [13], [14], [15], [16], [17], [18], [19],[20], [21]).
Reference [22] investigated the residual yield strength structural capacity effect of non-corroded,

corroded and inhibited steel bar. Results obtained showed that corrosion potential was recorded on uncoated reinforcement with cracks propagations while resin coated showed resistance. The results of coated steel bar with three different resins / exudates extracts of Symphonia globulifera linn, ficus glumosa and acardium occidentale l.) versus corroded on comparison, the flexural strength failure load are 29.50%, 28.505,29.57% against 22.30% corroded, midspan deflection are 31.14%,25.30%, 22.30% against 39,30% corroded, tensile strength 11.84%, 12.13%, 12.14% against 10.17% and elongation are 32.40%, 32.13%, 32.40% against 46.30% corroded. Overall results indicated that coated steel bar showed higher values increased in failure load and tensile strength while corroded decreased in elongation and midspan deflection.

Reference [23] investigated the effect on flexural residual yield strength capacity of three different resins/exudates extract of trees of dacryodes edulis, moringa oleifera lam, mangifera indica paste coated reinforcement on the concrete beam. Flexural strength failure loads of coated members with dacryodes edulis, moringa oleifera lam, mangifera indica are 35.78%, 27.09%, 29.42% against 22.30% decreased in corroded, midspan deflection are 18.57%, 28.30%, 27.43% against 39.30% increased in corroded, elongation are 28.75%, 31.50%, 31.60 against 46.30% increased in corroded and tensile strength are 14.18%, 12.29%, 12.08% as against 10.17% decreased in corroded respectively. Entire results showed that low load subjection is recorded in coated members at failure loads as against in corroded with high deflection and elongation. This high yield was attributed to corrosion attack.

Reference [24] examined the effect/impact of corrosion inhibitors on flexural strength of failure load, midspan deflection, tensile strength and elongation of steel reinforcement layered with resins/exudates of magnifera indica extracts as corrosion inhibitors. Results recorded on experimental work showed flexural strength failure load, midspan deflection, tensile strength and elongation as 29.09%,31.20%, 11.75% and 31.50% for non-corroded, 29.42%, 27.43%, 12.09% and 31.60% for coated concrete beam respectively. For corroded concrete beam members, failure load decreased to 22.505, midspan deflection increased by 39.30%, tensile strength decreased to 10.17% while elongation increased by 46.30%. Entire results showed the effect of corrosion on the flexural strength of reinforcement that led to low load on failure load and higher midspan deflection on corroded beams and hiher load on failure load and low midspan deflection on non-corroded and coated concrete beam members resulting to attack on surface condition of reinforcement from corrosion.

Reference [25] investigative study was carried out to ascertain the utilization of natural inorganic extracts of tree resin/exudates to assess the yield strength capacity of reinforced concrete beam members under corrosion accelerated medium. Results obtained showed presence of corrosion on uncoated concrete beam members with the presence of pitting and cracks. Non – corroded and coated members in comparison with corroded recorded increasing values on flexural strength failure load by 23.8% and 29.59% against 22.30% of corroded, tensile strength non – corroded and coated increased by 12.03% , 12.14% over 10.17 % of corroded while decreasing values on midspan deflection of 28.30% and 22.30%, elongation 31.5% and 32.46% recorded on non-corroded and coated concrete beam members as against 39.30% and 46.30% of corroded respectively. Overall results indicated lower failure loads on corroded and tensile strength on corroded members, higher load on midspan and elongation, resulted from an attack and degradation on the yield strength capacity due to corrosion potentials.

Reference [26] investigated the effects of corrosion on the residual structural steel bar capacity of resins/exudates inhibited and non-inhibited reinforced concrete beam members. Results obtained showed corrosion potential presence on uncoated members with cracks and spalling. Further recorded results on non-corroded flexural strength test of failure load 29.09%, midspan deflection 28.30%, tensile strength 12.03% and elongation 31.50%, for coated beam members, failure load 29.42%, midspan deflection 27.42%, tensile strength 12.09% and elongation 31.80%, for corroded beam members, failure load decreased by 22.50%, midspan deflection increased by 39.30%, tensile strength decreased to 10.17% and elongation by increased 46.30%. The entire experimental results showed that corroded specimens has lower flexural load, higher midspan deflection, lower tensile strength and higher elongation due to loss of steel bar fibre from degradation effect from corrosion, inhibitors served as protective coating against corrosion, but no strength was added to steel members.

Reference [27] investigated the effect of corrosion on the flexural strength and mid-span deflection of steel reinforcements coated with resins / exudates of trees extract known as inorganic inhibitors (dacryodes edulis-African Pear). The steel reinforcement members were embedded in concrete and exposed to harsh and saline environments (NaCl solution). Corrosion accelerated test were conducted on uncoated and dacryodes edulis resin pastes coated thicknesses of 150μm, 250μm and 300μm on steel reinforcement before corrosion test for 60 days to simulated corrosion process. Results obtained indicated that the flexural failure strength, and elongation increased by (29%) and (48%) respectively for the dacryodes edulis coated steel members, the mid-span deflection decreased by 26%, elongation increased by 23% and 32% respectively, while the mid-span deflection decreased by 40%.. The resin (mdacryodes edulis) added strength to the reinforcement.

Reference [28] experimented on the effects of corrosion and inhibitors (Inorganic origin) extracts known as resins/exudates from trees barks on the residual flexural strength of concrete beam members immersed in corrosion accelerated medium for 90 days to ascertain possible changes on surface conditions of investigated samples. Results from this experimental test recorded corrosion potential with visible signs of cracks, color change and spalling. Further results obtained of corroded concrete beam members were 22,50%, 39.30%, 10.19% and 46.30 of failure load, midspan deflection, ultimate tensile strength and elongation, for non- 29.09%, 28.30%, 12.03% and 31.50%, for coated beam members , 28.5%, 25.30%, 12.13% and 32.12% respectively. These results indicated increased in flexural failure load and ultimate tensile strength and decreased in midspan deflection and elongation respectively in corroded concrete beam members. This showed lower load and higher deflection in corroded members and higher in non-corroded and coated, higher elongation in corroded and lower in non-corroded and coated.

Reference [29] performed and investigated on uncoated and corrosion inhibitors (Symphonia globulifera linn) resins / exudates paste coated steel reforcing bar. Results obtained confirmed corrosion potential with the presence of stress within the steel and concrete surrounding, spalling and cracking. Further results obtained on comparison between uncoated (corroded) and coated are flexural failure load 22.50% to 29.50%, midspan deflection 39.30% to 31.14%, tensile strength 10.17% to 11.84% and elongation 46.30% to 32.40% respectively. Thus, results showed decreased in failure load and tensile strength of corroded members while increased in midspan deflection and elongation. This attributes was due to effect of corrosion and reduction in strength from degradation properties. Resins / exudates coated members showed higher failure load with low deflection.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Aggregates

The fine aggregate and coarse aggregate were purchased. Both met the requirements of [30]

2.1.2 Cement

Portland limestone cement grade 42.5 is the most and commonly type of cement in Nigerian Market. It was used for all concrete mixes in this investigation. The cement met the requirements of [31]

2.1.3 Water

The water samples were clean and free from impurities. The fresh water used was gotten from the tap at the Civil Engineering Department Laboratory, Kenule Beeson Polytechnic, Bori, and Rivers State. The water met the requirements of [32]

2.1.4 Structural Steel Reinforcement

The reinforcements are gotten directly from the market in Port Harcourt, [33]

2.1.5 Corrosion Inhibitors (Resins / Exudates) Cola acuminata

The study inhibitor (Cola acuminata Exudates) of natural tree resins/exudates extracts.

2.2 METHODS

Present study involves direct application of resins / exudates of trees extract known as inorganic inhibitor cola acuminata Exudates, layered/coated on reinforcement steel ribbed surface. The objective of this study was to determine the usefulness of locally available surface-applied corrosion inhibitors under severe corrosive environments and with chloride contamination. The test setup simulates a harsh marine environment of saline concentration. The samples of reinforced concrete beams of 150 mm x 150 mm × 650 mm, thickness, width and length specimens and ribbed bars of 16 mm embedded for corrosion test and flexural test for beam was investigated. This was aimed at achieving the real harsh and corrosive state, concrete specimens were ponded in solutions (NaCl) and the depth of the solution was maintained for the given period of experiment as to observe the significant changes that resulted from the actions of the accelerator (NaCl) and the specimens. The determination of the contribution of the resins will be observed through its adhesive ability with the reinforcement through surface coating application and the bonding relationship between the coated specimens and concrete, its waterproofing and resistive nature (resistance) against accelerator penetration into the bare reinforcement.

2.2.1 Specimen Preparation and Casting of Concrete Beams

Standard method of concrete mix ratio was adopted, batching by weighing materials manually. Concrete mix ratio of 1:2:4 by weight of concrete, water-cement ratio of 0.65. Manual mixing was used on a clean concrete banker, and mixture was monitored and water added gradually to obtain perfect mix design concrete. Standard uniform color and consistency concrete was obtained by additions of cement, water and aggregates. The test beams were cast in steel mould of 150mm x 150 mm x 750 mm. Fresh concrete mix for each batch was fully compacted by tamping rods, to remove trapped air, which can reduce the strength of the concrete and 16 mm reinforcements of coated and non-coated were spaced at 150 mm with concrete cover of 25 mm had been embedded inside the beam and projection of 100 mm for half-cell potential measurement. Specimens were molds are removed from specimen after 24hrs and cured for 28 days. The specimens were cured at room temperature in the curing tanks for accelerated corrosion test process and testing procedure allowed for 120 days first crack noticed and a further 30 days making a total of 150 days for further observations on corrosion acceleration process.

2.2.2 Flexure testing of Beam Specimens

Universal Testing Machine in accordance with BS EN 12390-2 was used for the flexural test and a total of 27 beam specimens were tested. After curing for 28 days, 6 controlled beams (non-corroded) was kept in a control state, preventing corrosion of reinforcement, while 18 beam samples of non-coated and exudates /resins coated were partially place in ponding tank for 150 days and examined accelerated corrosion process. After 150 days, the accelerated corrosion subjected samples were examined to determine residual flexural strength. Beam specimens were simply supported on a span of 650mm. An Instron Universal Testing Machine of 100KN capacity at a slow loading rate of 1 mm/min was used in the flexural test. Beam samples were placed in the machine to specification, flexural test were conducted on a third point at two supports. Load was applied to failure with cracks noticed and corresponding values recorded digitally in a computerized system.

2.2.3 Tensile Strength of Reinforcing Bars

To ascertain the yield and tensile strength of tension bars, bar specimens of 16 mm diameter of non-corroded, corroded and coated were tested in tension in a Universal Testing Machine and subjected to direct tension until failure; the yield, maximum and failure loads being recorded. To ensure consistency, the remaining cut pieces from the standard length of corroded and non-corroded steel bars were subsequently used in the bond and flexural test.

3. RESULTS AND DISCUSSIONS

Results of 27 samples in table 3.1, 3.2 and 3.3 are derived into average values in 3.4 and summarized into summary of averages, percentile values and percentile values difference **in** 3.5of flexural strength of concrete beam members as sampled, arbitrarily cast, cured for 28 days on normal and standard method, accelerated in corrosion medium environment for 120days at first crack s observation and 30days extended period and graphically represented in figures 3.1 - 3.3A.

3.1 Non-corroded Concrete Beam Members

Non-corroded (Controlled) flexural failure load of average values are 78.170kN, 78.05667kN, 78.52667kN, summarized to 78.251kN and represented 56.167% value against -35.965% corroded specimens. Midspan deflection average values are 8.433333mm, 8.676667mm, 8.136667mm, summed up to 8.415mm with and percentile difference of -45.060% over 82.017% corroded specimens. Yield strength average value is 460MPa, summed up to 100% with 0.00% of percentile value and difference, Average ultimate tensile strength, 630.1833MPa, 629.9167MPa, and 629.6167MPa, summed up to 629.905MPa, percentile difference of 16.003% over -13.7955% corroded specimens. Average strain ratios are 1.321667, 1.325, and 1.315, summed up to 1.320 with percentile difference values of 14.114% over -12.368%. Average elongations are 26.305%, 26.02833%, 26.42833%, summarized to 26.253% with percentile difference values of 89.4675% over -47.220%. Summarized results of non-corroded over corroded specimens showed that non-corroded (controlled) samples superseded corroded samples properties in low flexural failure, low midspan – deflection, normal yield strength, high ultimate strength, low strain ratio.

3.2 Corroded Concrete Beam members

Corroded member flexural failure load obtained from average values from table 3.2 into 3.4 and 3.5 and presented in figures 3.1 – 3.4A are 50.782833kN, 49.7295kN, 49.8095kN, summarized to 50.107kN with percentile value of -35.965% against 56.167% and 57.226% non-corroded and cola acuminata exudates coated specimens. Midspan deflection average values are 15.533333mm, 15.233333mm, 15.18667mm, summarized to 15.317mm with and percentile difference of 82.017% against -45.060% and -53.492% non-corroded and coated specimens. Average yield strength is 460MPa, summarized to 100% with 0.00% of percentile value. Ultimate tensile strength average values are 543.98333MPa, 542.45MPa, 542.5833MPa, summarized to 543.005MPa, percentile value -13.7955% against 16.003% and 15.913% of non-corroded and coated specimens. Strain ratio average values are 1.1583333, 1.165, and 1.148333, summarized to 1.157 with percentile value of -12.368% against 14.114% and 13.433% of non-corroded and coated specimens. Elongations average values are 13.943333%, 13.723333%, 13.90333%, summarized to 13.856% with percentile value of -47.220% against 89.4675% and 91.378% for non-corroded and coated specimens. Corroded members summarized results showed reduction in mechanical properties of reinforcing steel due to corrosion attack which has resulted to high yield with low load application, high midspan deflection and elongation, while coated members maintained high structural integrity.

3.3 Cola acuminata Resins/Exudates Steel Coated Concrete Beam Members.

Coated members average derived table 3.3 into 3.4 and 3.5 and presented in figures 3.1 – 3.4A of flexural failure load are 78.720667kN, 78.827333kN, 78.79733kN, summarized to 78.781kN with percentile value 57.226% against -35.965% corroded specimens. Midspan deflection average values are 7.0916667mm, 7.1483333mm, 7.131667mm, summarized to 7.123mm with and percentile value of -53.492% against 82.017% corroded specimens. Average yield strength, 460MPa, summarized to 100% with 0.00% of percentile value. Average ultimate tensile strength, fu, 629.4167MPa, 629.45MPa, 629.3833MPa, summarized to 629.415MPa, percentile value of 15.913% against -13.7955% corroded specimens. Average strain ratios are 1.321567, 1.3049, and 1.311567, summarized to 1.312 with percentile difference values of 13.433% over -12.368% of corroded specimens. Average elongations are 26.5009%, 26.55757%, 26.49757%, summarized to 26.518% with percentile values of 91.378% against -47.220% of corroded specimens. Coated members showed high flexural load before failure occurrence as compared to corroded members with low load to high yields and elongation.

Table 3.1: Flexural Strength of Beam Specimens (Non-Corroded specimens)

s/no	Non-corroded Control Beam									
Beam	Samples	XAG	XBG	XCG	XDG	XEG	XFG	XGG	XHG	XIG
WBX1-1	Failure Load (KN)	78.23	78.23	78.05	78.02	78.02	78.13	78.83	77.8	78.95
WBX1-2	Midspan Deflection (mm)	8.18	8.26	8.86	8.97	8.06	9	8.09	8.26	8.06
WBX1-3	Bar diameter (mm)	16	16	16	16	16	16	16	16	16
WBX1-4	Yield Strength, fy (MPa)	460	460	460	460	460	460	460	460	460
WBX1-5	Ultimate Tensile Strength, fu (MPa)	629.35	631.25	629.95	628.75	631.25	629.75	629.55	630.35	628.95
WBX1-6	Strain Ratio	1.345	1.305	1.315	1.345	1.315	1.315	1.315	1.305	1.325
WBX1-7	Elongation (%)	26.205	26.405	26.305	26.375	25.805	25.905	26.405	26.375	26.505

Table 3.2 : Flexural Strength of Beam Specimen (Corroded specimens)

s/no		Corroded Beam								
Beam	Samples	XAG1	XBG1	XCG1	XDG1	XEG1	XFG1	XGG1	XHG1	XIG1
WBX2-1	Failure load (KN)	51.1395	51.8195	49.3895	48.8695	51.1595	49.1595	48.9295	51.3595	49.1395
WBX2-2	Midspan Deflection (mm)	15.77	15.6	15.23	15.2	14.8	15.7	15.23	14.83	15.5
WBX2-3	Bar diameter (mm)	16	16	16	16	16	16	16	16	16
WBX2-4	Yield Strength, fy (MPa)	460	460	460	460	460	460	460	460	460
WBX2-5	Ultimate Tensile Strength, fu (MPa)	546.05	542.65	543.25	542.55	542.25	542.55	541.95	543.25	542.55
WBX2-6	Strain Ratio	1.165	1.155	1.155	1.195	1.145	1.155	1.155	1.145	1.145
WBX2-7	Elongation (%)	13.96	14.1	13.77	13.3	14.29	13.58	14.1	13.8	13.81

Table 3.3: Flexural Strength of Beam Specimens (Exudates/Resins Coated specimens)

		Cola acuminata exudates (steel bar coated specimen)								
s/no		150µm (Exudate/Resin) coated			300µm (Exudate/Resin) coated			450µm (Exudate/Resin) coated		
Beam	Samples	XAG2	XBG2	XCG2	XDG2	XEG2	XFG2	XGG2	XHG2	XIG2
WBX3-1	Failure load (KN)	78.304	79.254	78.604	78.644	79.004	78.834	78.604	78.644	79.144
WBX3-2	Midspan Deflection (mm)	7.195	6.595	7.485	7.295	6.855	7.295	7.275	7.275	6.845
WBX3-3	Bar diameter (mm)	16	16	16	16	16	16	16	16	16
WBX3-4	Yield Strength, fy (MPa)	460	460	460	460	460	460	460	460	460
WBXE-5	Ultimate Tensile Strength, fu (MPa)	628.95	629.85	629.45	629.45	629.45	629.45	629.05	629.55	629.55
WBX3-6	Strain Ratio	1.3149	1.3349	1.3149	1.3049	1.3049	1.3049	1.2949	1.3149	1.3249
WBX3-7	Elongation (%)	26.2609	26.8809	26.3609	26.3309	26.7809	26.5609	26.4709	26.1809	26.8409

` Table 3.4 : Average Flexural Strength of Beam Specimen (Non- Corroded, Corroded and Coated specimens)

s/no	Samples	Non-Corroded Specimens Average Values			Corroded Specimens Average Values			Coated Specimens Average Values		
WBX4-1	Failure load (KN)	78.17	78.056	78.5266	50.782833	49.7295	49.8095	78.720667	78.827	78.797
WBX4-2	Midspan Deflection (mm)	8.4333	8.6766	8.13666	15.533333	15.23333	15.1866	7.0916667	7.1483	7.1316
WBX4-3	Bar diameter (mm)	16	16	16	16	16	16	16	16	16
WBX4-4	Yield Strength, fy (MPa)	460	460	460	460	460	460	460	460	460
WBX4-5	Utimate Tensile Strength, fu (MPa)	630.1833	629.91	629.616	543.98333	542.45	542.583	629.4167	629.45	629.3833
WBX4-6	Strain Ratio	1.321667	1.325	1.315	1.15833	1.165	1.148333	1.321567	1.3049	1.3115
WBX4-7	Elongation (%)	26.305	26.028	26.4283	13.9433	13.72333	13.9033	26.5009	26.557	26.497

Table 3.5: Summary of Percentile Flexural Strength of Beam Specimens (Non-Corroded, Corroded, Exudates/Resins Coated Specimens)

Beam	Samples	Summary of Averages			Percentile Values			Percentile Difference		
WBX5-1	Failure load (KN)	78.251	50.107	78.781	156.167	64.033	157.226	56.167	-35.965	57.226
WBX5-2	Midspan Deflection (mm)	8.415	15.317	7.123	54.939	182.01743	46.507	-45.060	82.017	-53.492
WBX5-3	Bar diameter (mm)	16	16	16	100	100	100	0	0	0
WBX5-4	Yield Strength, fy (MPa)	460	460	460	100	100	100	0	0	0
WBX5-5	Ultimate Tensile Strength, fu (MPa)	629.905	543.005	629.415	116.003	86.204	115.913	16.003	-13.795	15.913
WBX5-6	Strain Ratio	1.320	1.157	1.312	114.114	87.631	113.433	14.114	-12.368	13.433
WBX5-7	Elongation (%)	26.253	13.856	26.518	189.467	52.779	191.378	89.4675	-47.220	91.378

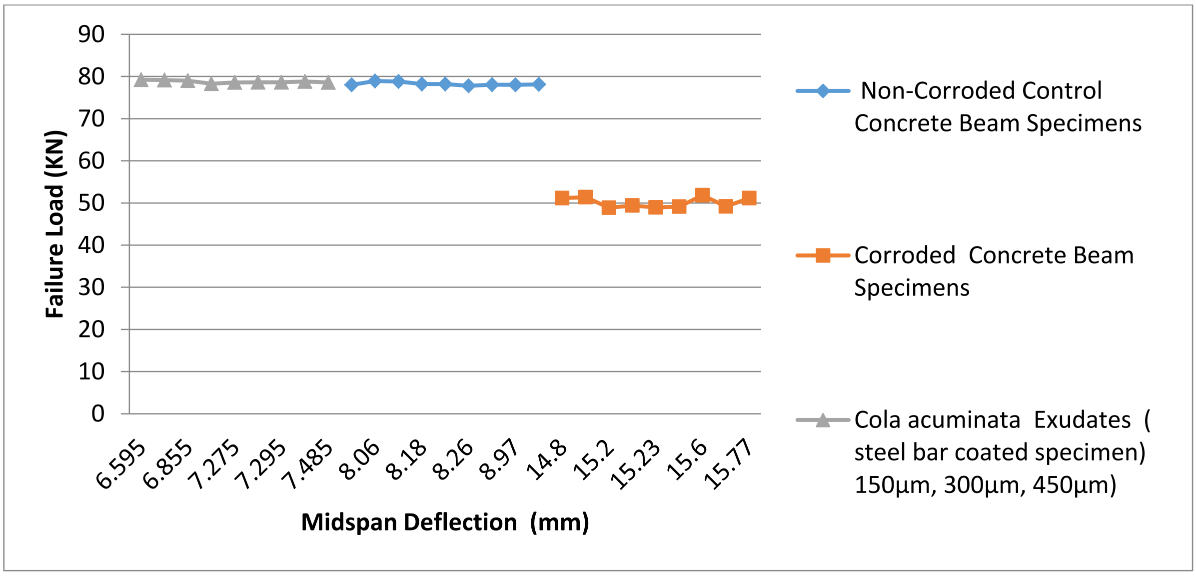

Figure 3.1: Failure Load versus Midspan Deflection of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

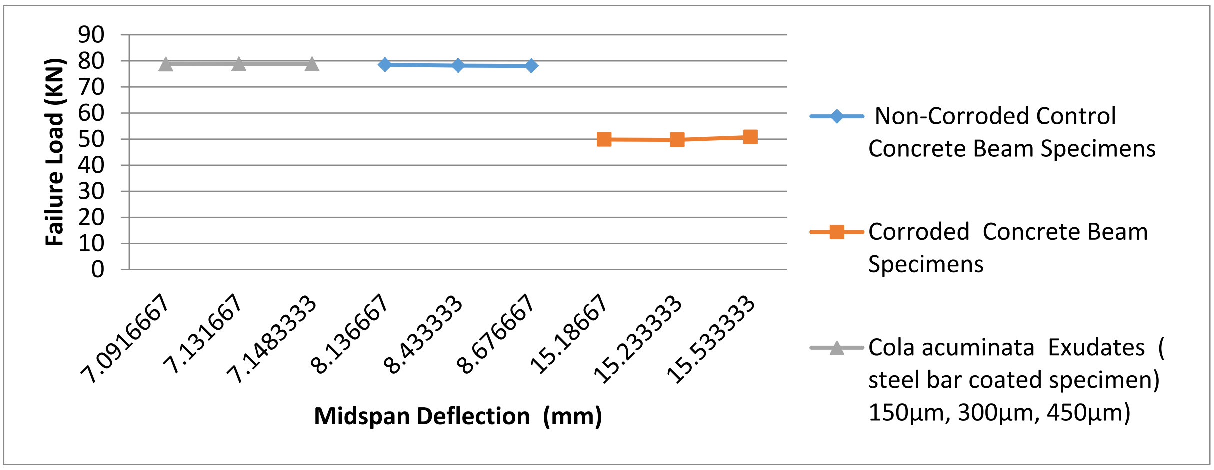

Figure 3.1A: Average Failure Load versus Midspan Deflection of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

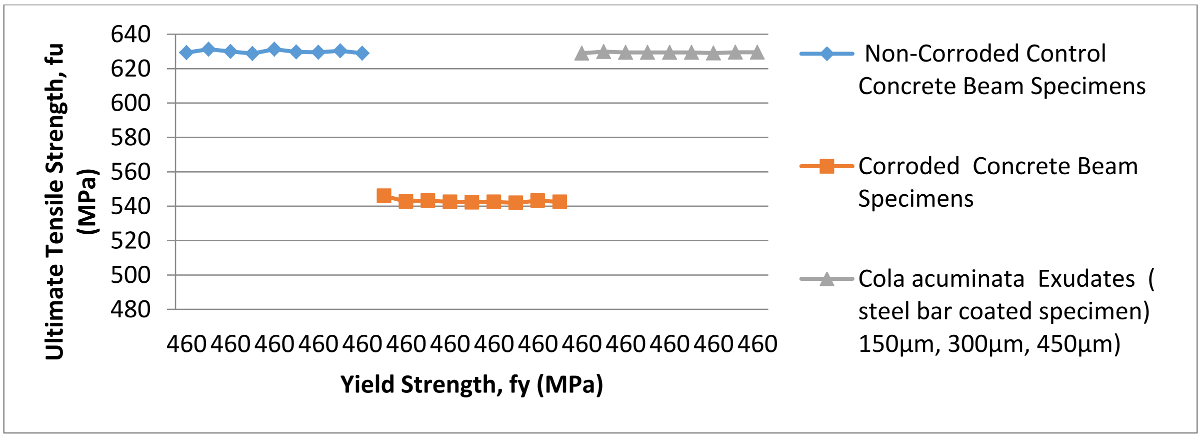

Figure 3.2: Ultimate Tensile Strength versus Yield Strength of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

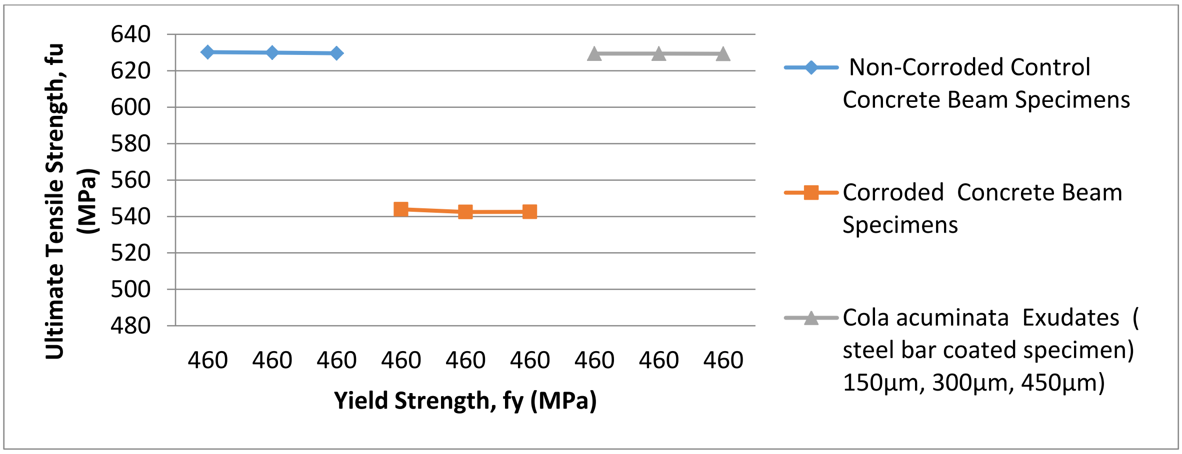

Figure 3.2A: Average Ultimate Tensile Strength versus Yield Strength of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

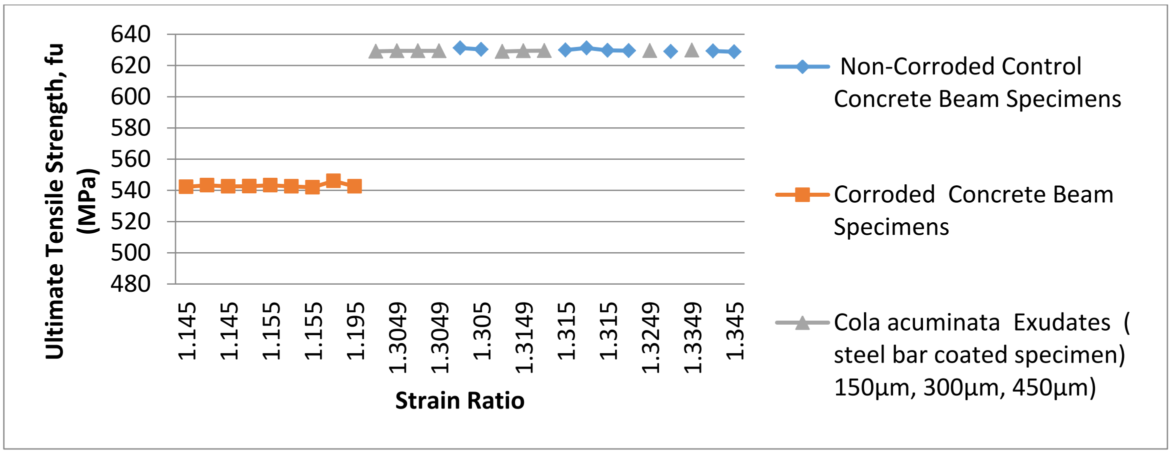

Figure 3.2A: Average Ultimate Tensile Strength versus Strain Ratio of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

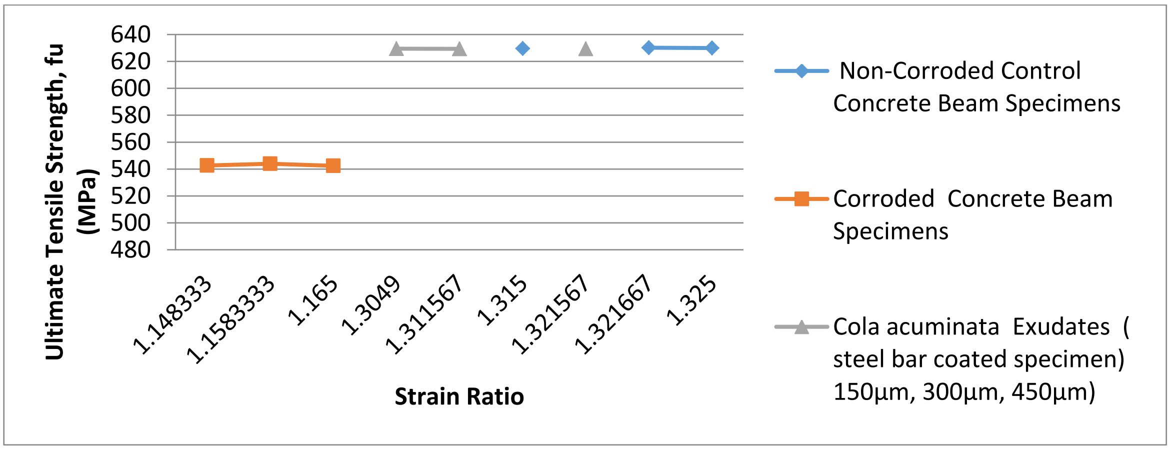

Figure 3.3A: Average Ultimate Tensile Strength versus Strain Ratio of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

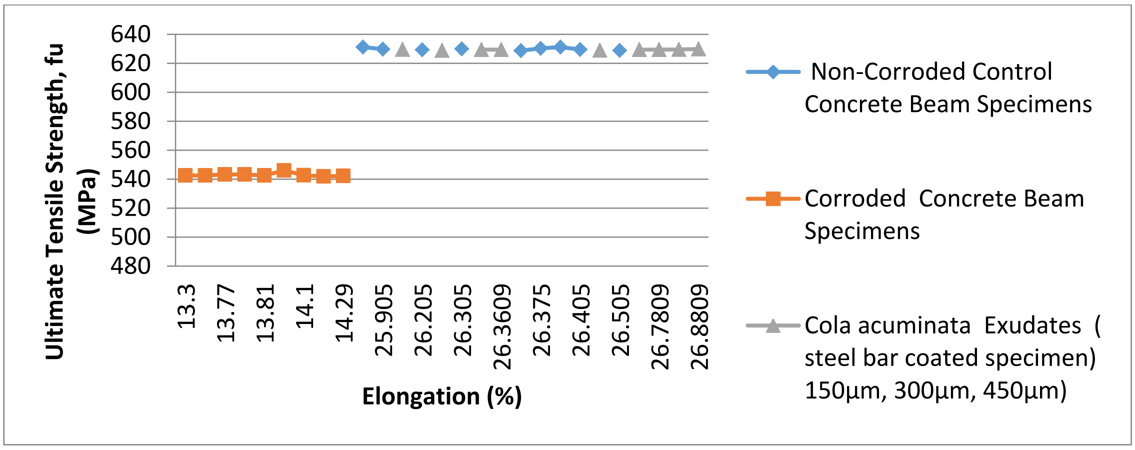

Figure 3.4: Ultimate Tensile Strength versus Elongation of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

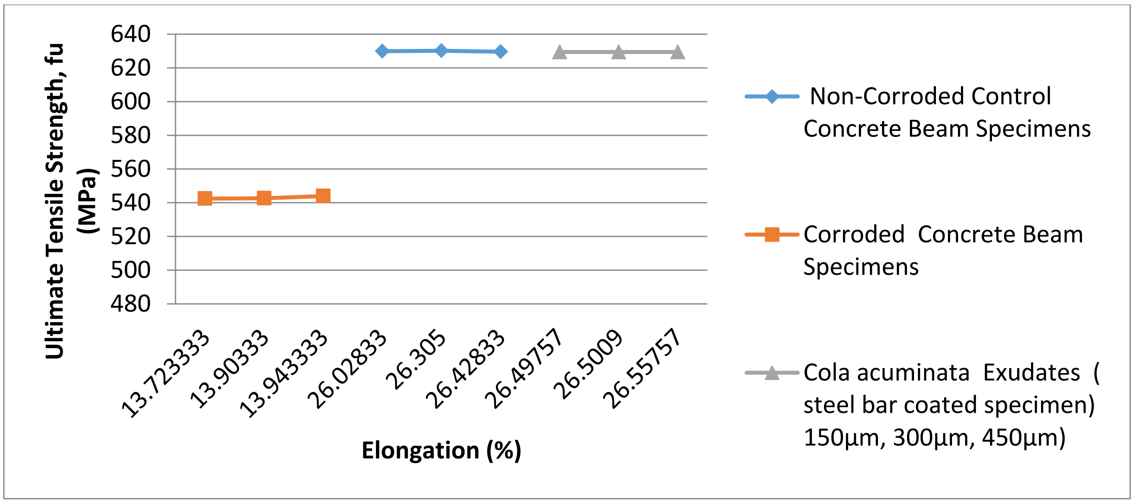

Figure 3.4A: Average Ultimate Tensile Strength versus Elongation of Beam Specimens (Non-Corroded, Corrode and Resin Coated Specimens)

4. CONCLUSIONS

Experimental results gotten from tables 3.1 – 3.5 and figures 3.1 – 3.3A, the below conclusions were drawn:

i. Corroded members summarized results showed reduction in mechanical properties of reinforcing steel due to corrosion attack which has resulted to high yield with low load application, high midspan deflection and elongation, while coated members maintained high structural integrity.

ii. Summarized results of non-corroded over corroded specimens showed that non-corroded (controlled) samples superseded corroded samples properties in low flexural failure, low midspan – deflection, normal yield strength, high ultimate strength, low strain ratio.

iii. Coated members showed high flexural load before failure occurrence as compared to corroded members with low load to high yields and elongation.

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