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Experimental Study of Mechanical Properties of Reinforcement bar under various coatings

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ABSTRACT

Due to rapid urbanization all over the world, there is a necessity to construct a structure with reinforcement of steel viz. High rise buildings, tunnels, railway sleepers, bridges, turbo generator foundations, nuclear power plants, dams, reservoirs etc. Corrosion of embedded steel of the pre-stressed structure is a universal problem and has revived scientific attention during the last few decades. In general the loss of alkalinity of steel caused by the entry of carbon dioxide leads to the corrosion of reinforcement, if moisture and oxygen are present. Many developments regarding to physical properties of embedded metal have come up.Some easily available common materials have been used to see their performance on the potential development at the metal solution interface polystyrene, red oxide, black Japan and aluminium paint have been examined. Bond strength between reinforcement and concrete is also taken into consideration while using paint as an anticorrosive material. The project is aimed at preventing corrosion that is minimising the rate of corrosion using various coatings. In this work an attempt is planned to study the effects of coating in reinforcement and to study the coating provided to the reinforcement. To accelerate the corrosion for a short term process of impressed is induced.

1.INTRODUCTION

In every country tons of steel is used to strengthen the concrete structures in the form of embedded ribs. Hence life of those embedded ribs pose a constant challenge of corrosion to scientists and engineers. The residual life of the concrete structures exposed to varied and aggressive environment depends on the depth of carbonation and de-alkalization of the cast-concrete is a well known phenomenon, yet focus on this aspect is very limited. Also, methods of de-carbonation and delayed alkalization have not been paid systematic research approach. When steel embedded in concrete corrodes, the increase in volume from metallic steel to corrosion product produces an expansive force, which can rupture the concrete. After a crack has been formed in this way, the steel corrodes even more rapidly, leading ultimately to complete failure of the structural member involved. Therefore premature deterioration of reinforced concrete structures due to corrosion of the reinforcing steel a concern worldwide.

Steel is widely and commonly used man made construction material in the world. It is obtained by mixing cementations material, water and aggregate in required proportions. The reinforced concrete is used throughout the world to build infrastructure and building. Today, the larger numbers of civil infrastructures around the world in a state of serious deterioration due to carbonation, chloride attack, etc,

Corrosion of reinforcement is the principal cause of deterioration of structural steel and a major economic cost for maintenance of national infrastructures. The effect of this deterioration on residual capacity is therefore a matter of concern to those charged with ensuring safe operation of concrete structures remain in service once reinforcement has started to corrode and cover concrete over the bars has began to spall, there is extensive evidence that modest amounts of corrosion do not pose an appreciable threat to structural stability.

It is essential that responsible engineers have at their disposal the means to verify that the affected structures retain an acceptable margin of safety. Corrosion may affect residual capacity through several mechanisms, including loss of bar section, loss of concrete section as a result of longitudinal cracking and stalling and a reduction in the interaction, or bond, between reinforcement and concrete.

Steel reinforcement is very effectively protected from corrosion by good quality of concrete, adequate thickness of cover and high alkalinity of the concrete. But due to various factors, the passive state of steel is lost and being to corrode.

1.1 OBJECTIVE

- The objective of this experiment is to measure the corrosion rate of two different metals.
- To show the effectiveness of the use of coatings to protect metal from corrosion.
- To apply protective coatings to the reinforcement.
- To compare the behaviour between coated and uncoated reinforcement bars.

1.2 SCOPE

- Service life, cost and effectiveness of various steel coating system can only be judged by field experience detailed with accurate records and evaluations of each system.
- Determine the initiation of corrosion and the rate of corrosion growth in the reinforcement materials.

2.METHODOLOGY

- Literature collection
- Material collection
- Test of specimen
- Test results
- Comparison of results
- Conclusion

3. MATERIALS

3.1 EPOXY COATING:

A high performance, multipurpose, surface tolerant, two components chemically curved epoxy semi-gloss coatings. It is a true universal coating for steel or masonry surfaces in immersing and non-immersion service. and also for concrete floors, interior dry walls, plaster and wood**.**

3.2 BP ZINC YELLOW PRIMER :

BP zinc yellow primer is an ideal primer for saline weather and heavily corrosive condition. It is one of the best primer suitable for mild steel surfaces. BP Zinc yellow primer is formulated with special type of synthetic alkyd binder and micro zinc pigment to withstand high degree corrosion. It is an air drying primer for mild steel and non-ferrous surfaces providing hard and tough film

3.3 ZINC CHROMIUM :

Zinc chromium acts as an anticorrosive pigment.It provides superior corrosion resistant.Primer based on this pigment are used as first coats and impart very good bonding properties to subsequent coats.It is used in solvents and vinyl based wash primers , metals conditioners or in aluminium flake coatings .

5.1 UTM TEST:

A universal testing machine (UTM),

- Also know as a universal tester, material testing machine or material test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tens meter.
- The universal part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile).

Fig .1 UNIVERSAL TESTING MACHINE

TABLE NO: 1

TMT bar zinc chromium 20mm diameter

S.no	Load (KN)	Dial gauge readings (cm)	Change in dimension (cm)	Area (mm^2)	Stress N/mm^2	Elongation (mm)	Strain (No unit)
1	0	0.000	50.000	201.03	0.000	0.000	1.00
2	10	0.181	50.181	201.03	0.049	0.366	1.37
3	20	0.391	50.391	201.03	0.099	0.782	2.15
4	30	0.548	50.548	201.0	0.148	1.096	3.24
5	40	0.782	50.782	201.03	0.198	1.564	4.80
6	50	0.931	50.931	201.03	0.248	1.862	6.60
7	60	1.164	51.164	201.03	0.297	2.328	8.90
8	70	1.301	51.301	201.03	0.347	2.602	11.5
9	80	1.400	51.400	201.03	0.396	2.800	14.3
10	90	1.519	51.519	201.03	0.444	3.038	17.4
11	100	1.620	51.620	201.03	0.469	3.240	20.6
12	110	1.721	51.721	201.03	0.545	3.424	24.0
13	120	1.800	51.800	201.03	0.595	3.600	27.6
14	130	1.901	51.901	201.03	0.644	3.802	31.5

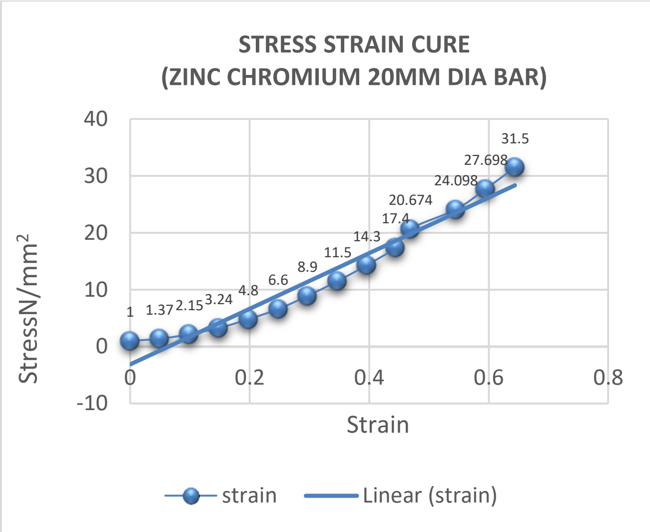

Fig. 2 STRESS STRAIN CURVE FOR ZINC CHROMIUM

TABLE NO: 2

S. NO	LOAD (KN)	DIAL GAUGE READING (cm)	CHANGE IN DIMENSIN (cm)	AREA (mm2)	STRESS (N/mm2)	ELONGATION (mm)	STRAIN (No Unit)
1	0	0.000	50.000	201.0	0.00	0.00	1.000
2	10	0.000	50.000	201.06	49.73	0.01	1.01
3	20	0.991	50.191	201.06	99.47	0.038	1.048
4	30	0.951	50.951	201.06	149.2	0.151	1.199
5	40	0.772	50.772	201.06	198.9	0.996	2.195
6	50	0.588	50.584	201.06	248.6	0.996	3.191
7	60	0.751	50.751	201.06	298.4	0.033	3.224
8	70	0.862	50.862	201.06	348.1	0.021	3.245
9	80	0.988	50.988	201.06	397.8	0.024	3.269
10	90	0.876	50.876	201.06	447.6	0.997	4.266
11	100	0.589	50.589	201.06	497.3	0.994	5.26
12	110	0.571	50.571	201.06	547.1	0.999	6.259

20 mm diameter TMT bar Bp zinc coating

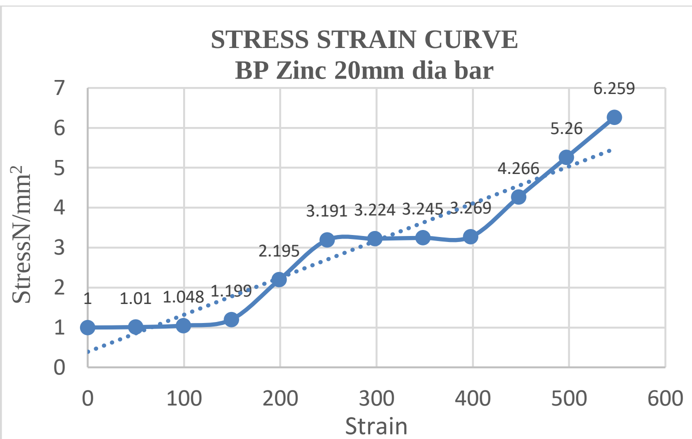

Fig.3 STRESS STRAIN CURVE FOR BP ZINC

TABLE NO: 3

TMT bar 20mm Epoxy coating

S. NO	LOAD (KN)	DIAL GAUGE READING (cm)	CHANGE IN DIMENSION	AREA (mm2)	STRESS (N/mm2)	ELONGATION (mm)	STRAIN (No Unit)
1	0	0.000	50.000	201.0	0.00	0.00	1.00
2	10	0.183	50.183	201.0	0.497	0.036	1.036
3	20	0.391	50.574	201.0	0.992	0.77	1.113
4	30	0.548	51.122	201.0	0.488	0.108	1.221
5	40	0.782	51.904	201.0	0.198	0.152	1.373
6	50	0.931	52.835	201.0	0.248	0.179	1.552
7	60	1.164	53.999	201.0	0.297	0.220	1.772
8	70	1.301	55.3	201.0	0.347	0.240	2.012
9	80	1.400	56.7	201.0	0.396	0.253	2.265
10	90	1.519	58.219	201.0	0.446	0.267	2.532
11	100	1.620	59.839	201.0	0.496	0.278	2.81
12	110	1.712	61.551	201.0	0.545	0.286	3.096
13	120	1.800	63.351	201.0	0.595	0.292	3.388
14	130	1.901	65.252	201.0	0.644	0.300	3.688
15	140	2.014	67.266	201.0	0.694	0.308	3.996
16	150	3.130	70.396	201.0	0.696	0.465	4.461
17	160	4.32	74.716	201.0	0.731	0.613	5.074
18	170	4.563	79.279	201.0	0.696	0.610	5.684
19	180	4.712	83.991	201.0	0.683	0.594	6.278

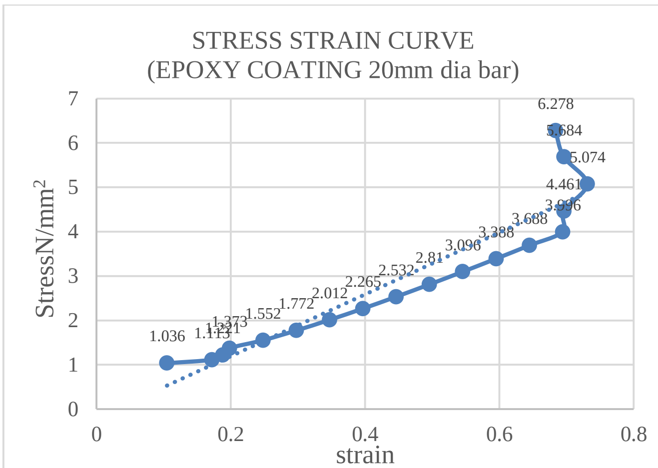

Fig.4 STRESS STRAIN CURVE FOR EPOXY COATING

S. NO	LOAD (KN)	DIAL GAUGE READING (cm)	CHANGE IN DIMENSION (cm)	AREA (mm²)	STRESS (N/mm²)	ELONGATION (mm)	STRAIN (No Unit)
1	0	0	60.000	314	0.000	0.00	1.000
2	10	0.012	60.012	314	31.85	0.02	1.002
3	20	0.042	60.042	314	63.69	0.07	1.009
4	30	0.093	60.093	314	95.54	0.16	1.169
5	40	0.121	60.121	314	127.3	0.20	1.369
6	50	0.173	60.173	314	159.2	0.29	1.659
7	60	0.261	60.261	314	191.0	0.44	2.099
8	70	0.317	61.317	314	222.9	0.53	2.629
9	80	0.389	61.389	314	254.7	0.65	3.279
10	90	0.453	61.453	314	286.6	0.76	4.039
11	100	0.498	62.498	314	318.4	0.83	4.869
12	110	0.532	62.532	314	350.3	0.89	5.759
13	120	0.614	63.614	314	382.1	1.02	6.779
14	130	0.631	64.631	314	414.0	1.05	7.829
15	140	0.753	64.899	314	445.8	1.27	1.013
16	150	0.843	65.742	314	455.4	1.41	1.014
17	160	1.843	67.585	314	477.7	3.07	1.031

TABLE NO: 4

20mm diameter bar uncoated

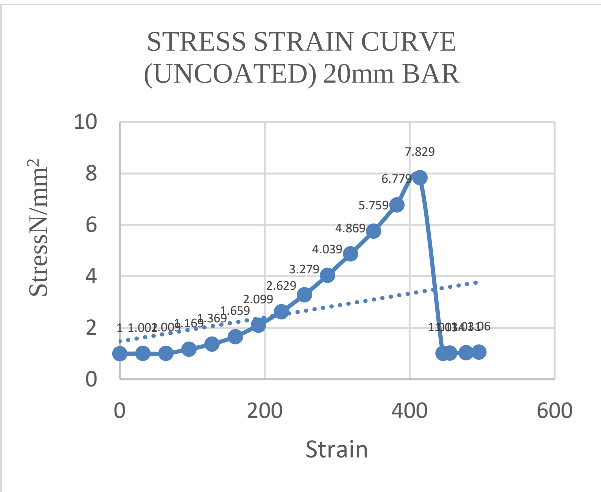

Fig.5 STRESS STRAIN CURVE FOR UNCOATED BAR

METHODS USED TO INDUCE THE CORROSION:

ACCELERATED CORROSION TEST:

In reinforcement bars were casted and the insulated copper wires are connected to the main reinforcement of the slabs at the corresponding points while casting. The metal above the steel in galvanic series can be used as sacrificial anode current is passed in reinforcement of slabs after filling the top of the slabs with salt water, which contains 3% of sodium chloride. The current is passed from a DC power supply. Positive terminal of the DC power supply is connected to the main reinforcement of the reinforcement bar and negative terminal is connected to the steel plate, which also kept immersed in the salt water.The density of current is around 1.8 to 2.0 of the surface area of the rod was induced corrosion. The slabs placed in the tank were subjected to a current density of 1.8 from external DC source. The stainless steel plate which acts as cathode was placed below the slab. The stainless steel plate was 1.5mm thick. The current density was adjusted using knobs provided in D.C rectifier to maintain a constant current density throughout the test.

ACCELERATED CORROSION TEST

TABLE NO: 5

20mm Epoxy Coating (after corrosion)

S. No	Load (KN)	Dial gauge readings (cm)	Change in dimension (cm)	Area (mm²)	Stress N/m m²	Elongation (mm)	Strain (No Unit)
1	0	0.00	50.00	314	0.000	0.00	1.000
2	10	0.90	50.90	314	31.00	1.034	2.635
3	20	0.89	51.79	314	63.00	1.052	3.927
4	30	0.67	52.46	314	95.00	1.089	5.099
5	40	0.51	52.97	314	127.0	1.089	6.248
6	50	0.52	53.49	314	159.0	1.096	7.360
7	60	0.45	53.94	314	191.0	1.121	8.456
8	70	0.43	54.37	314	222.0	1.129	9.585
9	80	0.63	55.00	314	254.0	1.138	10.72
10	90	0.76	55.76	314	286	1.149	11.84
11	100	0.76	56.52	314	318	1.172	12.94
12	110	0.68	57.20	314	350	1.292	14.02
13	120	0.69	57.89	314	382	1.299	15.08
14	130	0.44	58.33	314	414	2.321	16.17
15	140	0.79	59.12	314	445	2.800	17.20

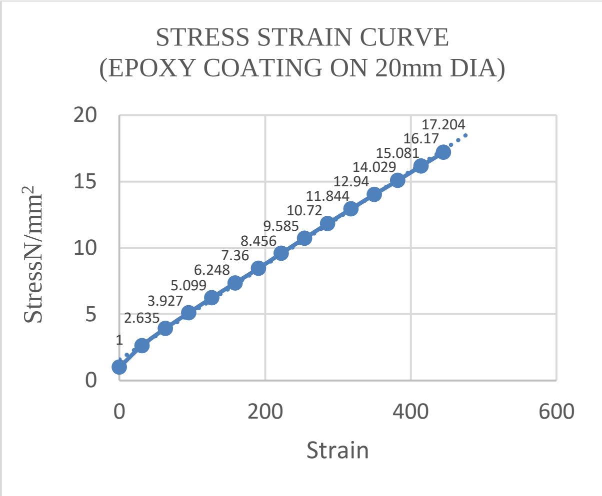

Fig.6 STRESS STRAIN CURVE FOR EPOXY COATING AFTER CORROSION

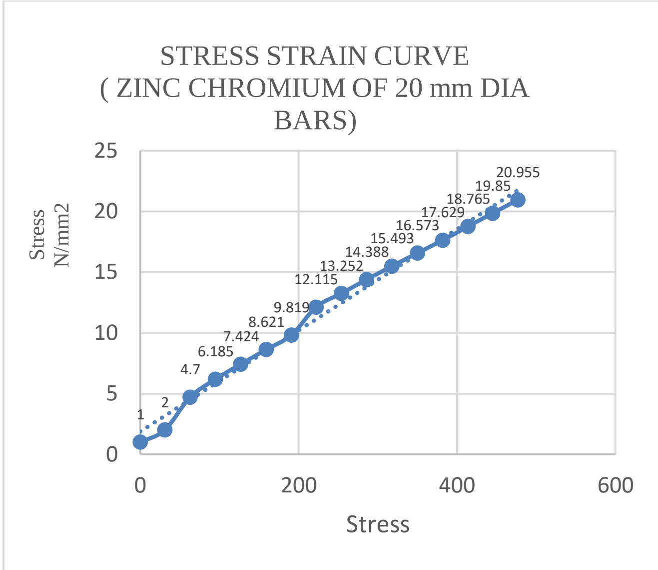

Fig.7 STRESS STRAIN CURVE FOR ZINC CHROMIUM AFTER CORROSION

TABLE NO: 6

20mm Diameter ZINC CHROMIUM(after corrosion)

S no	Load (KN)	Dial gauge readings (cm)	Change in dimension (cm)	Area (mm^2)	Stress (N/mm^2)	Elongation (mm)	Strain (No Unit)
1	0	0.00	50.00	314	0.00	0.00	1.00
2	10	0.00	50.00	314	31.00	1.00	2.00
3	20	0.85	50.85	314	63.00	1.170	4.70
4	30	0.65	51.5	314	95.00	1.197	6.18
5	40	0.48	51.98	314	127.00	1.198	7.42
6	50	0.49	52.47	314	159.00	1.148	8.62
7	60	0.59	53.06	314	191.00	1.239	9.81
8	70	0.53	53.59	314	222.00	1.137	12.1
9	80	0.56	54.15	314	254.00	1.136	13.2
10	90	0.63	54.78	314	286.00	1.080	14.3
11	100	0.56	55.34	314	318.00	1.056	15.4
12	110	0.47	55.81	314	350.00	1.105	16.5
13	120	0.36	56.17	314	382.00	1.085	17.6
14	130	0.91	57.08	314	414.00	1.105	18.7
15	140	0.65	57.73	314	445.00	1.239	19.8
16	150	0.87	58.6	314	477.00	1.270	20.9

TABLE NO: 7

20mm diameter bar BP Zinc (after corrosion)

S no	Load (KN)	Dialgauge readings (cm)	Change in dimension (cm)	Area (mm^2)	Stress (N/mm^2)	Elongation (mm)	Strain (No Unit)
1	0	0.00	50.00	314	0.00	0.000	1.00
2	10	0.98	50.98	314	31.00	1.019	2.01
3	20	0.97	51.95	314	63.00	1.019	3.03
4	30	0.51	52.46	314	95.00	1.009	4.04
5	40	0.68	53.14	314	127.00	1.012	5.05
6	50	0.93	54.07	314	159.00	1.017	6.07
7	60	0.18	54.25	314	191.00	1.003	7.07
8	70	0.57	54.82	314	222.00	1.010	8.08
9	80	0.96	55.78	314	254.00	1.017	9.10
10	90	0.35	56.13	314	286.00	1.006	10.1
11	100	0.76	56.89	314	318.00	1.013	11.1
12	110	0.11	57.00	314	350.00	1.001	12.1
13	120	0.33	57.33	314	382.00	1.005	13.1
14	130	0.71	58.04	314	414.00	1.012	14.1
15	140	0.143	58.18	314	445.00	1.002	15.1

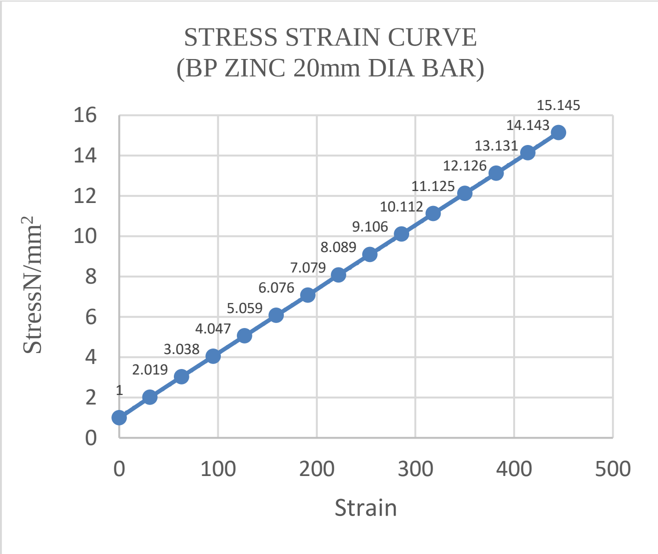

Fig.8 STESS STRAIN CURVE FOR BP ZINC COATING AFTER CORROSION

TABLE NO: 11

Comparison between Epoxy Coating , BP Zinc, Zinc Chromium(after coated 20mm dia bars)

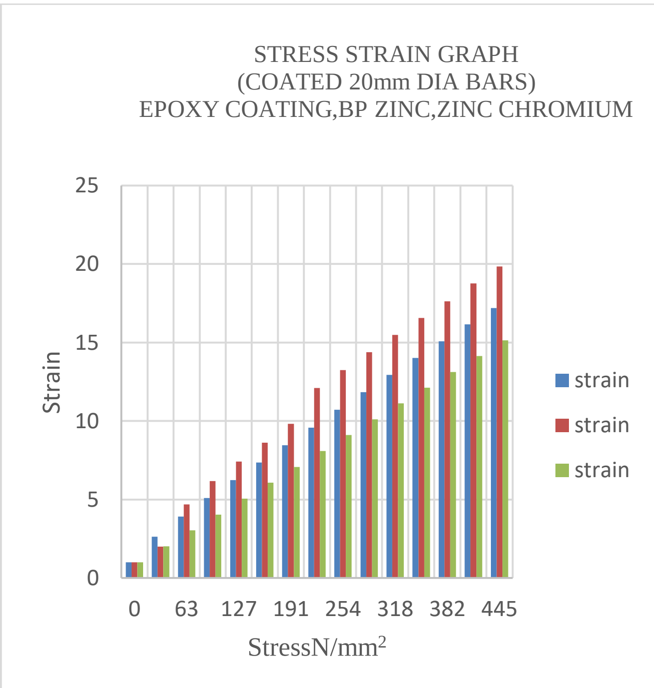

Fig.9 STRESS STRAIN GRAPH COMPARISON BETWEEN EPOXY COATING, BP ZINC, ZINC CHROMIUM

CONCLUSION

We used three types of coatings in these BP Zinc coatings provides more strength and elongation than other coatings.When compared to other coatings BP Zinc has high hardness .Compared to other coatings Zinc chromium has increased strain values.As compared other coatings BP Zinc has increased flexibility.When compared to conventional rod coated rod has less corrosion.When compared to normal coated rod the rods after the corrosion test have more strength, flexibility and hardness.Finally the test results of these three coatings BP ZINC provides more strength, durability, flexibility and high elongation.

REFERENCE

1. **Dhir R.K, Jones M.R and McCAthy.M.J (March 1994)** "Chloride Induced Reinforcement Corrosion" Research 46, No.169, Dec 269-277
2. **Dugarte M..SagtiesA.A,Powers R.G., Lasa,(2007)** evaluation of point for corrosion prevention in reinforced concrete", paper No, 07304,14 pp., corrosion
3. **Gonzalez,J.Aet al (March 1998)** "The effect of chloride ions on the corrosion of steel reinforcement Research, vol 50.no.pp.190-197
4. **Gonzalez,J.Aet al (March 1990)** "The Mechanism Of Steel corrosion in reinforcement bars. Research, vol.42, No.pp.23-27
5. **Jumaat.M.Z, and Rahman.M.M and alam .M.A. (June 2010)** "Flexural strength of RC structures", 'International Journal of the physical science' vol.5(6),pp.6199-625.
6. **Makita M.,Mori,Y., and Katawaki,k (1980)** "Corrosion behaviour of reinforced exposed to Tokyo bey", performance of concrete Sp65-16,ACI deposit,,pp.271-289.
7. **Sukumar P.(2000)** "Experimental Investigation on the reduction of corrosion in Reinforcement using epoxy zinc coated bars". M.E, thesis Coimbatore institute of technology
8. **Thangavl K.et al(1995)** "Influence of protective coating on steel "Indial Journal, Vol 69 No.5pp289-293