3394115/2024/O/o CAO/CORE/PRYJ

Central Organisation for Railway Electrification
1-Nawab Yusuf Road, Civil Lines, Prayagraj (UP)-211001
Fax No-0532-2408826, www.core.indianrailways.gov.in

No. ELCORE/MP/Vendor Confidential/2018 Pt –I

Date: 20/11/2021

All CORE Approved Vendors

Sub: Quality measures of fabrication and galvanization of steel.
Ref: Institute of Chemical Technology report Dated 27.11.2020

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1.0 In above cited subject and reference, some black patches were observed on galvanised structures of fabricated and galvanized steel structure in RE Group 223 Surendranagar – Pipavav section. Joint inspection was conducted and also some samples were sent to ICT Mumbai through RITES for checking performance of galvanization.

2.0 The following conclusion is made.

(A) The measurement of zinc coating thickness was carried out as per the specifications, and it was observed that the thickness of the coating was more than required. Also, the mass of the zinc coating was determined and is much more than specification, hence, the zinc deposition on the structure is more than required, which causes black spots on the coating surface.

(B) Paint coating applied on the galvanization may give following effects:
i) Black spots on galvanized surface causes off shading of color.
ii) Peeling of paint will also occur due to black spots on the galvanized surface.
iii) Improper surface with black spots cause crawling of paint.

3.0 Firm is hereby advised to following remedial action should be taken.

Excess of zinc deposition was observed based on results, which causes black spots on the coating surface. Also, the uniformity of zinc should be proper.

b) Improper rinsing with water after galvanization also causes black spots on the coating surface; hence, ICT would recommend proper rinsing and cleaning of the galvanized surface.

c) The excess ppm (parts per million) level of surplus aluminium while galvanization in the galvanizing bath causes the scattered black spotting, therefore, ppm level of surplus aluminium should be as low as possible.

d) Storage of the galvanized material should be moisture-free, as, water deposition also causes the blackening of the galvanized surface and may further lead to rusting.

In addition to above report Rubber tube at Chain crossing and providing wooden block between mast and chain to avoid rubbing of the binding chain with the Galvanized structure.

It is advised to all CORE approved vendor for implementation of Quality measures of fabrication and galvanization of steel structures mentioned ICT reports (copy enclosed).

DA: As enclosed.

20.11.

(Kalyan Singh)
Dy. Chief Electrical Engineer (MP)
CORE/Prayagraj

INSTITUTE OF CHEMICAL TECHNOLOGY
Campuses - Matunga, Mumbai • IOC Bhubaneswar, Odisha • Marathwada, Jalna
Category I Deemed to be University (MHRD/UGC) A++ Grade by NAAC (CGPA 3.77)
Elite Status and Centre of Excellence-Govt. of Maharashtra

Professor (Dr.) S. T. MHASKE
HEAD,
Department of Polymer and Surface Engineering
Fellow, Maharashtra Academy of sciences

Date: November 27, 2020

To,

RITES LIMITED

Western Region

Churchgate Station Bldg,

Second Floor, M. K. Road

Mumbai – 400 020

Subject: Expert Opinion Report

This is in reference to your letter No.RITES.WR.BD.17 (2020-21)/ICT dated October 08, 2020 for work of and expert opinion report on performance of galvanization. Outcomes are mentioned as an attached copy titled as **"Expert Opinion Report"**.

PROFESSOR S. T. MHASKE
Head of Department
Dept. of. Polymer & Surface Engg
Institute of Chemical Technology, (ICT)
Matunga, Mumbai - 400 019.

Expert Opinion Report

"Root cause analysis and for improvement of galvanized steel structure"

Measurements/Tests carried out:

1) **Visual Inspection:**
   a) All samples are free from flaws.
   b) All samples are free from rough jagged and imperfect edges
   c) Galvanization:
      i) The galvanization on all samples is smooth.
      ii) The galvanization on all samples is bright but, blackspots are observed on the surface of the coating in the visual inspection as shown in Figure 1 (Red dotted markings).
      iii) All samples are free from pimples and blisters on the surface

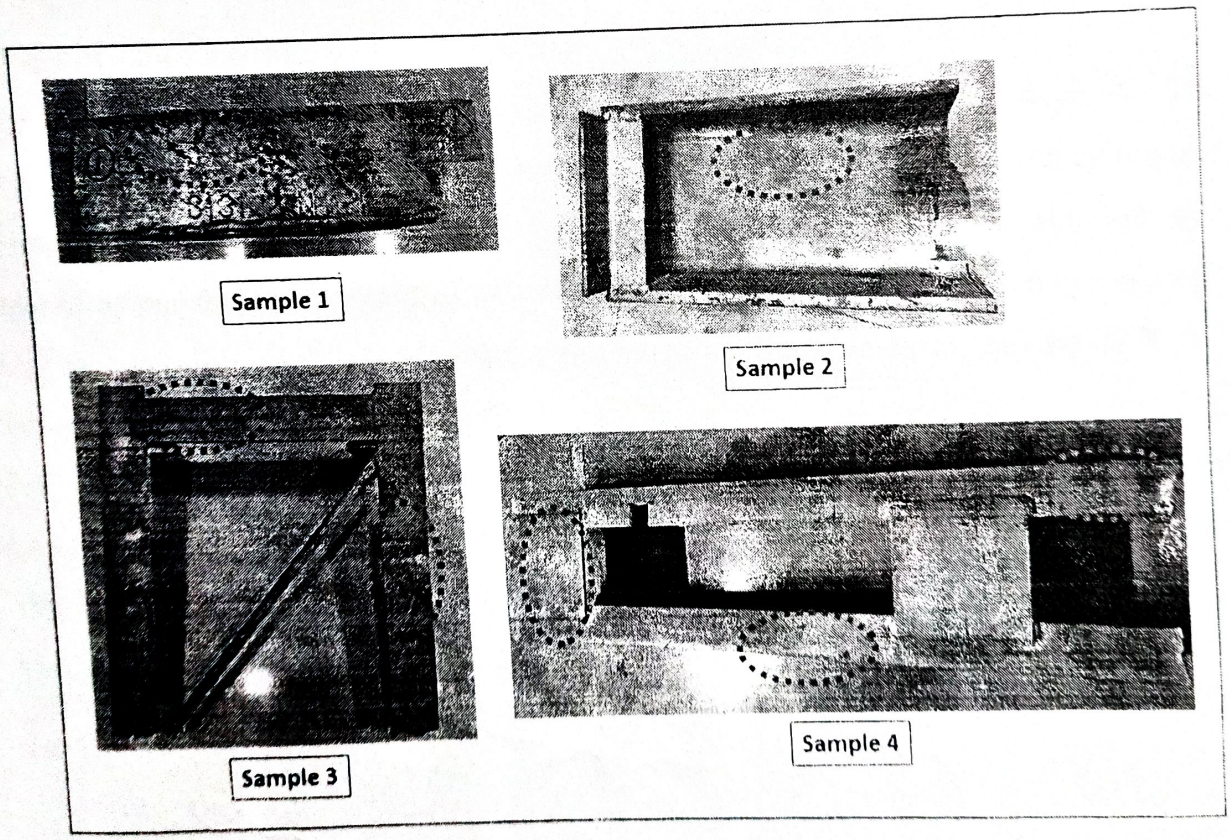


Figure 1: Photographs of galvanized steel structures

2) **Galvanization Tests:**
   a) Measurement of Zinc coating thickness by Elcometer:

The measurement of zinc coating thickness was carried out as per specification No. ETI/OHE/13(4/84) with the help of Elcometer. The thickness was measure at ten different locations on every sample. All results are shown in Table 1.

Table 1: Zinc coating thickness by Elcometer

Sr. No.	Item	Zinc Coating Thickness (in microns)									
		1	2	3	4	5	6	7	8	9	10
1	NMTPL Make, RI 3131-2 1PCS Weight 4.5 kg	146	132	189	128	143	131	140	143	141	134
2	0076/1A DA-2, 1PCS NMTPL Weight 21.5 kg	142	167	162	169	152	171	170	168	160	174
3	NO. NMTPL Make Weight 12 kg	119	116	123	132	108	109	119	124	117	128
4	Sample 4	90	74	86	84	87	110	85	112	124	88

b) Mass of Zinc Coating:

The mass of zinc coating was determined as per the details given in annexure 'A'. The test pieces were prepared with a weight of less than 200 grams and washed with an organic solvent, then with ethanol, and finally dried thoroughly. The stripping solution was prepared as per the given specification immediately before the test. All the cleaned test specimens were weighed before testing. After weighing immerse each piece singly in test solution as per specifications and allow to remain there until the evolution of hydrogen. After that, the piece was removed, cleaned, dried, and weighed. The mass of the zinc coating (in gm/m^2) was calculated as per the given formula and the results are showed in Table 2.

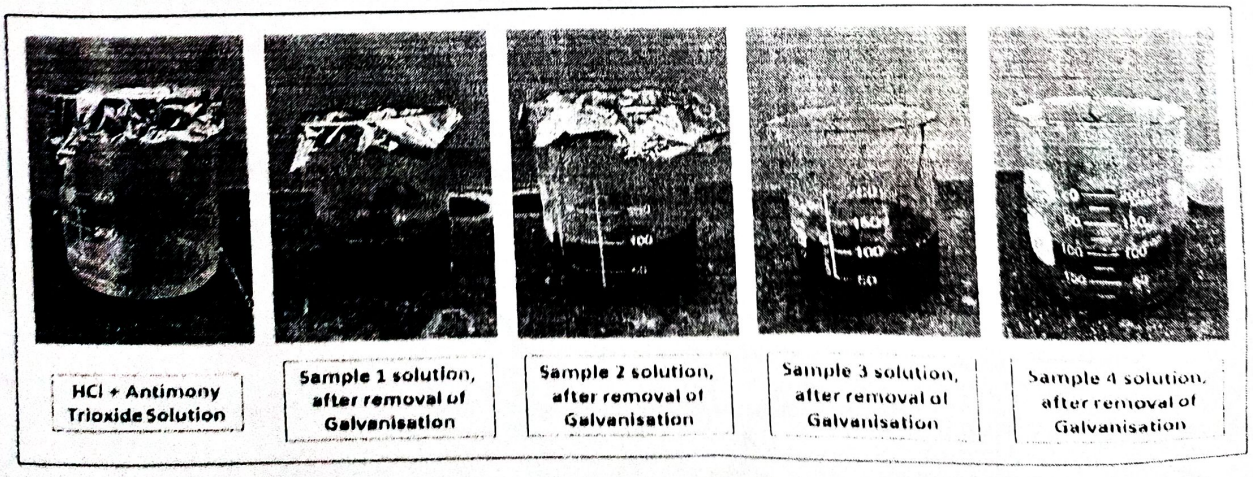


Figure 2: Change in color of stripping solution after removal of zinc coating

c) Uniformity of Zinc Coating

Uniformity of galvanized coating was checked by Preece Test as per the given specifications.

d) Adhesion of Zinc Coating

Adhesion of the samples was characterized by the Cross-hatch adhesion test and Knife test as per the specifications (No. ETI/OHE/13(4/84), and the results are shown in Table 2.

Table 2: Mass of zinc, Uniformity of zinc coating, Adhesion test

Sr. No.	Item	Mass of Zinc Coating (g/ M^2)	Uniformity of Zinc Coating	Adhesion Test
1	NMTPL Make, RI 3131-2 1PCS Weight 4.5 kg	2410	Any deposition is not observed	No peel off of zinc coating is observed
2	0076/1A DA-2, 1PCS NMTPL Weight 21.5 kg	3227	Any deposition is not observed	No peel off of zinc coating is observed
3	NO. NMTPL Make Weight 12 kg	2129	Any deposition is not observed	No peel off of zinc coating is observed
4	Sample 4	1924	Any deposition is not observed	No peel off of zinc coating is observed

3) Result and discussion:

a) Scattered black spotting may be caused by residual galvanizing flux crystallizing on the surface of the work and is mostly because of flux contaminated rinse water or poor rinsing after galvanizing. This flaw is typically seen in galvanizing baths using the "wet" galvanizing process where the flux is on top of the molten zinc. Surplus aluminium in the galvanizing bath can also be the reason for this defect.

b) Zinc is a very reactive material and will form zinc oxide when mixed with oxygen from the air; this is the thin hard layer that forms the protective film associated with galvanized coatings. The coating needs carbon dioxide to create this layer $2ZnCO_3.3Zn(OH)_2$. Once formed, this layer is weather-resistant and minimizes further corrosion.

The problem arises when galvanized parts are deprived of air and exposed to moisture. This causes a different set of chemical changes in the zinc. Droplets of water, when flattened between two surfaces such as items mounted to pallet rack beams create problematic environments for zinc, which needs exposure to air. The zinc is attacked by the water and zinc ions constantly leave the coating to be bound by the water; the

absence of carbon dioxide accelerates the corrosion. The zinc cannot be converted to zinc hydroxide to form the protective film and corrosion will persist as long as these conditions prevail.

c) As in the case with iron fines, mechanical damage to the substrate can also induce Zn-Fe alloy growth (outbursts) in galvanizing. If the alloys grow through the coating thickness, grey or black spots will appear on the coating surface.

4) Conclusion:

a) Visual inspection of the galvanized coating was carried out and from the observations, it was cleared that the coating surface was free from flaws, rough jagged, and imperfect edges. Although the galvanized surface was smooth and bright, blackspots were observed on the coating surface.

b) The measurement of zinc coating thickness was carried out as per the specifications, and it was observed that the thickness of the coating was more than required. Also, the mass of zinc coating was determined and is much more than specification, hence, the zinc deposition on the structure is more than required, which causes black spots on the coating surface

c) Adhesion of the samples was characterized and no peel off of zinc coating is observed, therefore, the adhesion of galvanized zinc is good.

d) Dull grey coating is only displeasing to the eye and is not a defect at all. In fact, grey coating, compared to a bright coating, is abrasion resistance and is chemically more protective in some environment. Variation in coating appearance does not adversely affect the level of corrosion protection provided and structural stability. (Ref. IS 2629)

e) Paint coating applied on the galvanization may give following effects:

i) Blackspots on galvanized surface causes off shading of color.

ii) Peeling of paint will also occur due to black spots on the galvanized surface.

iii) Improper surface with blackspots causes crawling of paint.

5) Inputs on remedial actions from ICT:

a) Excess of zinc deposition was observed based on results, which causes black spots on the coating surface.

b) Improper rinsing with water after galvanization also causes black spots on the coating surface, hence, ICT would recommend proper rinsing and cleaning of the galvanized surface.

c) The excess ppm level of surplus aluminium while galvanization in the galvanizing bath causes the scattered black spotting, therefore, ppm level of surplus aluminium should be as low as possible.

d) Storage of the galvanized material should be moisture-free, as, water deposition also causes the blackening of the galvanized surface and may further lead to rusting.