POST-FIRE METALLURGICAL ASSESSMENT OF GALVANIZED ANCHORS SUPPORTING A TELECOMMUNICATIONS TOWER

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A zinc-coated tower undergoes rigorous field testing and laboratory analysis to determine if the material integrity was preserved despite exposure to fire.

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A common issue during post-fire inspections of galvanized steel structures is the misinterpretation of surface discoloration—particularly dark or blackened areas—as active corrosion, similar to that seen on bare carbon steel. This often results from a limited understanding of zinc coating behavior under high temperatures.

Discoloration in fire-exposed galvanized structures can arise from phenomena such as localized melting, zinc oxidation, or intermetallic phase changes. While visually significant, these changes do not necessarily indicate a loss of corrosion protection or structural integrity. The image on the opening page of this article shows a wildfire as an immediate threat to a power transmission structure.

In the telecommunications and electrical transmission and distribution (T&D) sectors, reliance on visual inspection alone can lead to inaccurate assessments and premature replacement of assets. A more rigorous evaluation—incorporating electrochemical testing, coating thickness measurements, and metallurgical analysis—is essential for accurate condition assessment and sustainable asset management.

BACKGROUND

This paper presents a case study of a post-fire assessment on a guyed telecommunications tower with anchor shafts exposed to wildfire. Matergenics Inc. conducted a detailed inspection to evaluate thermal damage, assess structural integrity, and determine the condition of the galvanized protective coatings. The findings highlight the importance of science-based evaluation protocols to support informed repair decisions and ensure the continued safety and reliability of critical infrastructure.

CASE STUDY: TELECOMMUNICATIONS TOWER EXPOSED TO WILDFIRE

The telecommunications tower used to support antennas for wireless communication is stabilized using anchor shafts and guy wires. The tower is connected to the anchor shafts through tensioned guy wires, which extend from the tower to the shafts at specific angles. This configuration helps maintain vertical alignment, resists environmental forces, and ensures structural integrity for reliable signal transmission.

The tower featured in this case study was affected by a wildfire in September 2024. The site included the main tower and three sets of

Fig. 1 — Telecommunications tower featured in this case study.

Fig. 2 — Photograph showing guy wires of anchor BB with visible discoloration.

Fig. 3 — Photograph showing guy wires of anchor CC.

Fig. 4 — Closer view of one of the anchor BB guy wires clearly shows discoloration. Dark looking deposits are byproducts of combustion.

Fig. 5 — Closer view of one of the anchor CC guy wires clearly shows no exposure to wildfire.

Fig. 6 — Photographs showing that the site is affected by wildfire. Images on the left were taken during the inspection on June 8, 2024, while images on the right were captured during the inspection on January 21, 2025.

Fig. 7 — Zee Probe from Matergenics.

anchors labeled AA, A, BB, B, CC, and C. While the tower itself was unaffected, some anchors showed signs of fire-related residue.

Visual examination. Figure 1 shows the condition of the site. The site included six anchor foundations comprised of galvanized steel I-beam shafts. Visual examination revealed that anchors B and BB exhibited dark deposits resembling soot or char, indicating exposure to wildfire. Anchors A, AA, C, and CC remained clean and free of discoloration, suggesting they were either shielded or located in a less affected area. Figures 2 through 5 show the condition of anchors BB and CC.

The site was impacted by wildfire. As shown in Fig. 6, a comparison of the conditions around anchors AA and BB with the site conditions during the previous inspection on June 8, 2024, reveals significant changes. Vegetation in the surrounding area was severely affected by the wildfire with noticeable damage including burnt and scorched plant life. These visual changes highlight the wildfire's impact on the site and its immediate surroundings.

Electrochemical potential mapping using Zee Probe. To assess the condition of the galvanized coating and remaining corrosion protection on the anchors, electrochemical potential measurements were conducted using a Zee Probe (Fig. 7) on anchors AA, B, and BB. This technique helps identify whether the surface consists of intact zinc, a zinc-iron intermetallic layer, or bare steel. Anchor AA, which was unaffected by fire, showed readings between -0.91 and -0.97 V, confirming a well-preserved galvanized coating. In contrast, fire-exposed anchors B and BB showed readings from -0.56 to -0.88 V, indicating partial degradation of the zinc layer, with some regions likely retaining intermetallic layers or thermally altered zinc. These results suggest that although some thermal damage occurred, the galvanizing layer still offers a degree of corrosion protection.

Galvanized layer thickness measurement using a coating thickness gauge. The galvanized layer thickness

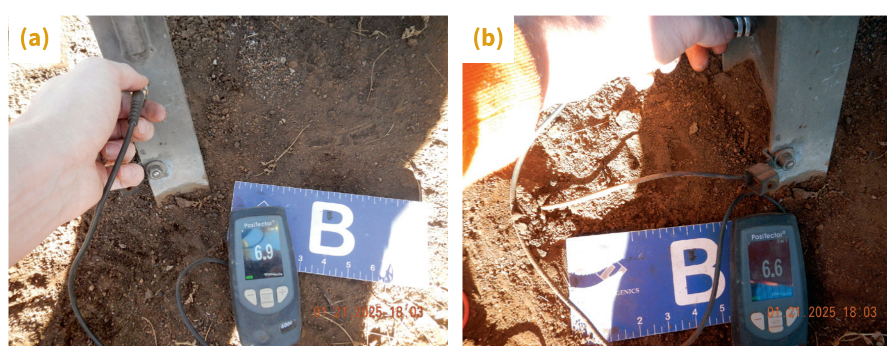


Fig. 8 — Photographs show galvanized layer thickness of anchor B (I-beam): (a) Galvanized layer thickness at flange; and (b) galvanized layer thickness at web.

TABLE 1 – GALVANIZED LAYER THICKNESS, mils

Location	Anchor shaft				Fan plate			
Anchor AA	6.1	6.2	7.0	6.2	5.6	6.6	12.1	7.6
Anchor B	8.6	6.9	6.6	7.0	6.6	7.0	5.9	6.3
Anchor BB	14.2	7.1	6.4	7.2	6.3	6.8	7.1	8.1

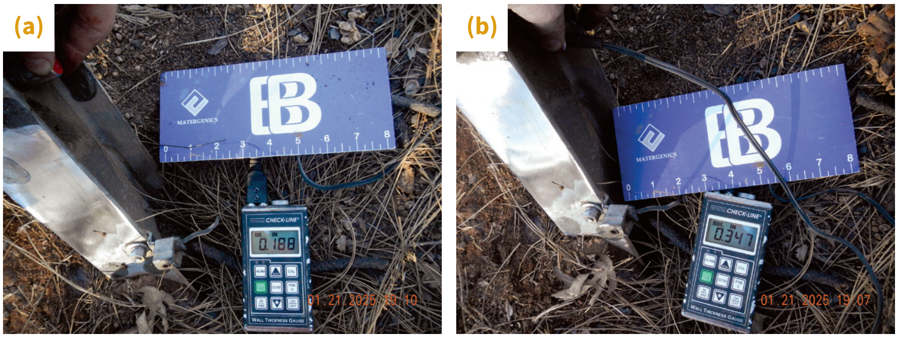


Fig. 9 — Photographs showing wall thickness of anchor BB (I-beam): (a) Wall thickness at web; and (b) wall thickness at flange.

TABLE 2 – WALL THICKNESS, in.

Location	Flange thickness		Web thickness	
Anchor AA	0.386	0.337	0.196	0.189
Anchor B	0.364	0.348	0.182	0.189
Anchor BB	0.347	0.382	0.173	0.188

of anchor shafts and fan plates for anchors AA (unexposed), B, and BB (wildfire-exposed) was measured using a coating thickness gauge, with representative images shown in Fig. 8 and summarized results in Table 1. A comparative analysis was conducted to assess whether wildfire exposure caused any degradation or thinning of the galvanized coating. The measurements revealed generally consistent thickness across all anchors, indicating no significant loss of the protective zinc layer due to fire. One higher-than-expected reading at anchor BB was likely due to surface deposits or contaminants affecting the measurement rather than a true variation in coating thickness.

Fig. 10 — Photographs showing Vickers hardness values of anchor AA (flange).

Wall thickness measurement using an ultrasonic gauge. Ultrasonic measurements were taken to assess the wall thickness of the web and flange sections of I-beam-shaped anchors AA (unexposed), B, and BB (wildfire-exposed), as shown in Fig. 9, with results summarized in Table 2. A comparative analysis evaluated whether wildfire exposure caused any material loss that could affect structural performance. Wall thickness values across all three anchors were found to be consistent, with no significant thinning observed. These findings indicate that the wildfire exposure did not compromise structural integrity of the anchor shafts.

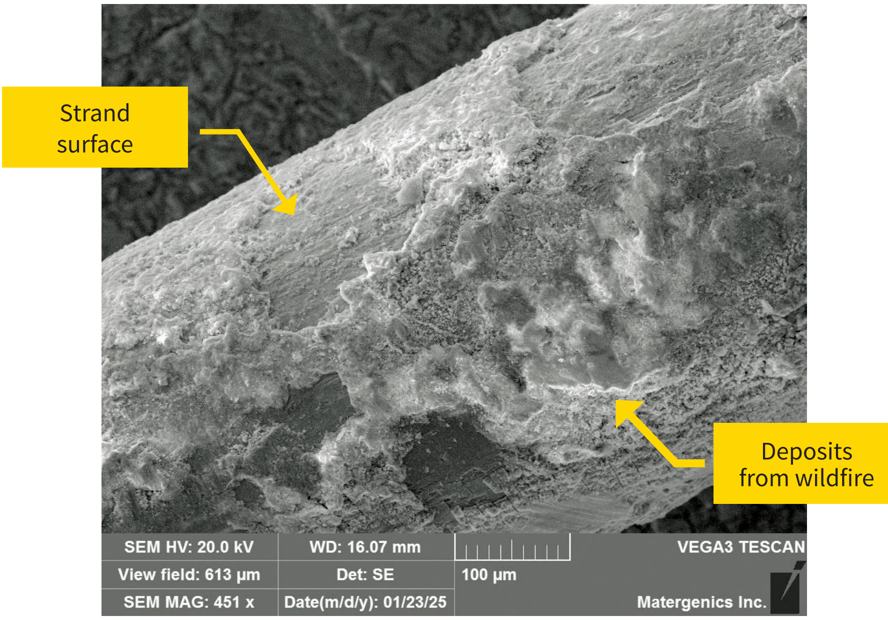
In-situ hardness test. Vickers hardness testing was conducted on the flanges of I-beam-shaped anchors AA (unexposed), B, and BB (wildfire-exposed) using a portable hardness tester. To access the base metal, flange surfaces were ground to expose the underlying carbon steel, and zinc-rich paint was applied afterward to protect the exposed areas. A representative image of the testing is shown in Fig. 10, and the recorded values are summarized in Table 3. A comparative analysis revealed consistent hardness values across all three anchors with no significant abnormalities observed. These results indicate that wildfire exposure did not adversely affect the material hardness or structural integrity of the anchors.

SEM/EDS analysis. A small strand sample from a wire rope at anchor BB

Fig. 11 — Small strand sample from wire rope at anchor BB removed for examination.

TABLE 3 – VICKERS HARDNESS, HV

Location	1	2	3	4	5	Average hardness
Anchor AA	102	101	102	93.2	101	100
Anchor B	118	100	98.3	87.9	101	101
Anchor BB	102	113	91.4	121	108	107



Element	Wt%	At.%
C	6.19	12.63
O	40.18	61.57
Na	4.02	4.29
Al	1.79	1.63
Si	2.08	1.82
K	0.39	0.25
Fe	12.73	5.59
Zn	32.61	12.23

Elemental composition of the deposits.

Element	Wt%	At.%
C	0.01	0.04
O	17.28	43.43
Al	0.93	1.38
Si	0.19	0.27
Fe	44.70	32.19
Zn	36.89	22.69

Elemental composition of the strand surface.

Fig. 12 — EDS data clearly shows that the surface of the strand has elemental composition similar to the intermetallic phase on the galvanized steel surface and the oxides of zinc, which suggests the temperature was not high enough to melt the zinc and leave only the steel surface. EDS data of the deposits is similar to soot and fly ash.

was manually removed for subsequent lab examination (Fig. 11). The sample was examined at higher magnifications using scanning electron microscopy (SEM), and the elemental composition of the deposits on the strand was checked using energy dispersive spectroscopy (EDS).

SEM examination of the strand sample revealed deposits on its surface. Elemental composition of these deposits was analyzed through EDS, with results showing significant variations (Fig. 12). Deposits primarily consist of carbon, oxygen, sodium, aluminum, silicon, potassium, iron, and zinc. Weight percentages for these elements in the deposits were as follows: C (6.19%), O (40.18%), Na (4.02%), Al (1.79%), Si (2.08%), K (0.39%), Fe (12.73%), and Zn (32.61%). Elemental composition of the strand surface itself showed a slightly different distribution with iron at 44.70%, zinc at 36.89%, and oxygen at 17.28%, suggesting that the deposits are predominantly composed of soot and fly ash.

EDS data clearly indicate that the strand surface has an elemental composition similar to the intermetallic phase found on the galvanized steel surface and the oxides of zinc. This suggests that the temperature during

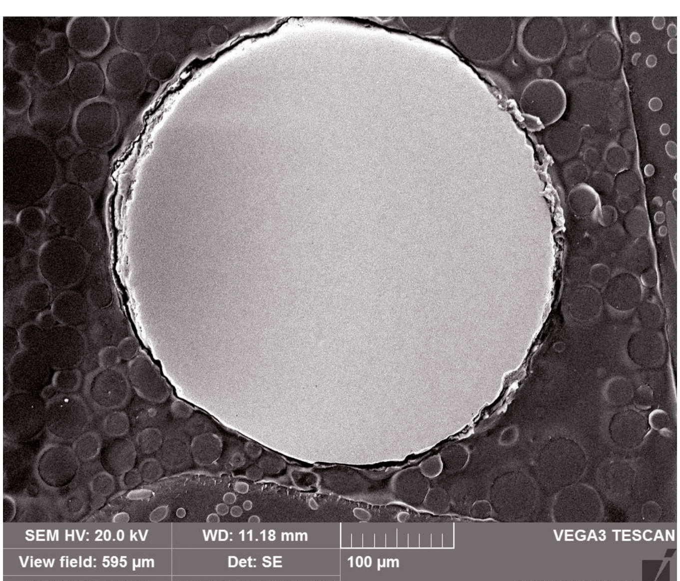


Fig. 13 — SEM image shows cross-section of strand considered for examination at higher magnification.

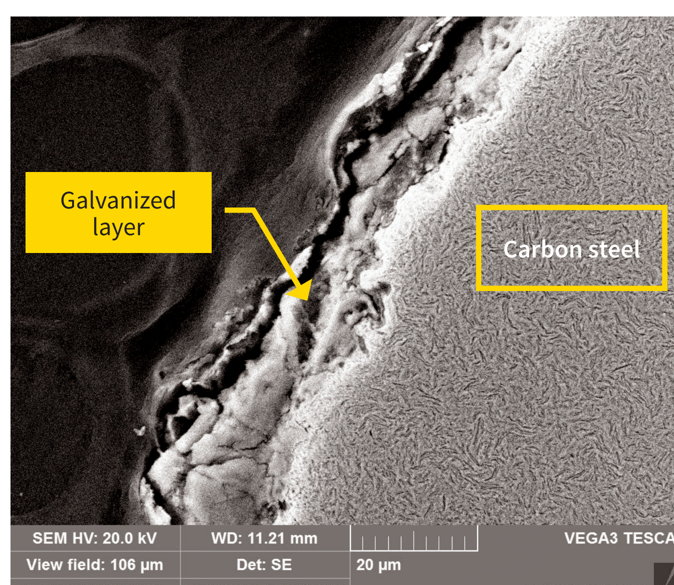


Fig. 14 — SEM examination confirms the presence of a galvanized layer on the strand surface. Microstructure consists of martensite.

exposure was not high enough to melt the zinc and leave behind just the steel surface. EDS analysis of the deposits further confirms the composition is likely soot and fly ash, typical by-products of combustion or high-temperature exposure.

Following SEM examination of the strand surface, a transverse cross-section was extracted from the strand sample. The cross-section was then ground and polished to a 1-μm surface finish and subsequently etched using a 2% Nital solution. Figures 13 and 14 provide a comprehensive SEM analysis of the wire rope strand, focusing on its microstructure and the presence of a galvanized layer. Figure 13 shows the cross-section of the strand examined at a higher magnification to gain detailed insights into its structure. Figure 14 confirms the presence of a galvanized layer on the strand surface with the microstructure identified as martensite. The microstructure at the core of the strand is examined, and it is also found to consist of martensite. Consistency in the martensite microstructure between the surface and core indicates that the temperatures during exposure were not high enough to alter the microstructure at the surface, which further suggests the strand did not undergo significant thermal degradation or phase transformation. This uniformity in microstructure across the surface and core confirms that the material's integrity was preserved, even under the conditions it was exposed to.

CONCLUSIONS

Based on site observations, field testing, and laboratory analysis, it was concluded that anchors B and BB exhibited surface deposits consistent with wildfire residue, while anchors AA and CC remained unaffected. No melting or severe oxidation was observed on any anchors and surrounding fencing, though discolored, retained structural integrity. Pre- and post-fire comparisons confirmed environmental damage without compromising core structural elements of the tower. Galvanized coatings on anchor shafts and fan plates remained intact with only minor anomalies likely caused by surface deposits, and hardness measurements showed no material degradation. SEM/EDS analysis of wire strands from anchor BB identified the deposits as soot and fly ash, with no evidence of coating failure due to heat.

To mitigate long-term risks, it is recommended to clean affected areas—ideally with pressure washing—to remove potentially corrosive residues and to consider installing EnviroZense for real-time corrosion and wildfire temperature monitoring. These types of sensors enable remote assessment and help ensure the continued structural integrity and reliability of the tower should future wildfire events occur. **~AM&P**

Note: Zee Probe and EnviroZense are registered trademarks of Matergenics Inc.

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