Measured Performance of Aluminized Type 2 Coated CSP

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History of NCSPA

National Corrugated Steel Pipe Association

- Founded in 1956
- Organized to promote the responsible use of corrugated steel drainage products, including pipe and buried bridges

www.NCSPA.org
History of NCSPA

- 65 fabricating plants across the country and nearly 100 worldwide
- 14 different gage thicknesses
- 12 profile options
- 3 primary coatings available
- 4 band types
- Buried Bridge arches, vs round vs bottomless
  - with at least 15 different geometries
Presentation Outline

- What is Aluminized Type 2?
- Evolution of research
- DOT implementation
What is Aluminized Type 2?

• **Barrier** vs **Sacrificial Coating**

• Zinc is a barrier coating
  • Cathodic protection
• Aluminized is a sacrificial coating
  • Soft water, high resistivity
What is Aluminized Type 2?
AASHTO and ASTM Specifications

- AASHTO M274 “Steel Sheet, Aluminum-Coated (Type 2) for Corrugated Steel Pipe
Composition of the Aluminized Type 2 Coating

The coating bath metal composition shall be as follows (all percentages are maximum): Iron, 3.0 %; silicon, 0.35 %; magnesium, 0.50 %; other, each, 0.05 %; other, total, 0.20 %; balance, aluminum.
## Composition of the Aluminized Type 2 Coating

<table>
<thead>
<tr>
<th>Type</th>
<th>Coating Weight [Mass], Total Both Sides</th>
<th>Equivalent Coating Thickness, Total Both Sides</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Triple Spot, Average, min oz/ft² [g/m²]</td>
<td>Single Spot, min oz/ft² [g/m²]</td>
</tr>
<tr>
<td>Zn</td>
<td>2.00 [610]</td>
<td>1.80 [550]</td>
</tr>
<tr>
<td>Zn</td>
<td>4.00 [1220]</td>
<td>3.60 [1100]</td>
</tr>
<tr>
<td>Zn-5Al-MM</td>
<td>2.10 [640]</td>
<td>1.80 [550]</td>
</tr>
<tr>
<td>55Al-Zn</td>
<td>0.70 [210]</td>
<td>0.60 [180]</td>
</tr>
<tr>
<td>Al Type 2⁸</td>
<td>1.00 [305]</td>
<td>0.90 [275]</td>
</tr>
<tr>
<td>Al Type 1</td>
<td>1.00 [305]</td>
<td>0.90 [275]</td>
</tr>
</tbody>
</table>

Al T2 coating: 1 oz/ft² (305 g/m²) = 0.00374 in. (95 microns)
Single spot 275 g/m² = 86 microns
Field Studies

- FHWA Studies
  - FHWA FLP 91-006
  - FHWA RD 97-140

- Steel Industry Studies
  - Armco/AK Steel 30, 43, 50, and 60 year studies
  - Additional sites located by industry in 2014
    - Oregon
    - Georgia
2014 Field Study

- Digital Camera
- Cordless drill, extra battery and charger with a 1.5” drill bit
- Ultrasonic Thickness Gage
  - TI-25M
- Dry Film Thickness Gage
  - DCF – 3000FX
- pH and water hardness test strips
- Bug spray, buckets, shovels, etc
2014 Field Study
2014 Field Study

- Environmental data collection
- pH, hardness, flow characteristics
  - Core sample removal and testing
- Taken at the 6 o’clock position or as close to the invert as feasible
- Ultrasonic thickness data collection
  - Taken at the crown and as close to the invert as feasible
2014 Field Study
What is Aluminized Type 2?

100 μm
Coating Data

16 ga

50 μm

alloy

free Al

steel substrate

16 ga

80.00

70.00

60.00

50.00

40.00

30.00

20.00

10.00

0.00

0

5

10

15

SEC Data

AKS Data

Free Aluminum Data

Free Aluminum + Alloy Data

Alloy Data

12 ga

50 μm

28 μm

40 μm

25 μm

44 μm

9 μm

28 μm

25 μm

9 μm

87 μm

67 μm

31 μm

28 μm

68 μm

28 μm

87 μm

31 μm

28 μm

25 μm

9 μm

44 μm

28 μm

40 μm

25 μm

44 μm

9 μm

28 μm

25 μm

9 μm

44 μm

28 μm

25 μm

12 ga

80.00

70.00

60.00

50.00

40.00

30.00

20.00

10.00

0.00

0

5

10

SEC Data

AKS Data

Free Aluminum Data

Free Aluminum + Alloy Data

Alloy Data
Coating Data

10 Gage Samples with all detectors w STD < 5.22
Coating Data

12 G with all detectors & STD < 5.27
Coating Data

14 G w all detectors & STD < 3.92
Coating Data

16 G w all detectors & STD < 4.69
Coating Data

AVG

10G  12G  14G  16G
Field Performance of Aluminum Coating on Aluminized Type 2 Steel Pipe in the Atlanta Metro Area

*REMAINING ALUMINUM COATING (FREE ALUMINUM & ALLOY LAYER)*

- Installed on 40% slope
- Installed on 16% slope

*Does not include substantial additional years of service life provided by the steel pipe structure itself*
Coating Process

W-S-W per AASHTO T-213 Sec. 6, each side separate

Note the variation in grams/meter\(^2\) relative to the measured thickness using the hand held devices (green boxes)

Figure 6. Graphical summary of the averages and ranges: (grams of coating) / (sq. meter) per micron of measured thickness.
CONCLUSIONS

- The data confirms current service life guidance for Aluminized Type 2 CSP, where 16 gage steel provides a minimum of 75 years of service life when the FHWA abrasion level is 2 or less, the pH range is from 5 to 9, and the resistivity is greater than 1500 ohm-cm or greater than 5000 ohm-cm with a pH of 4.5 to 5.

- And in future inspections, it is recommended that the industry take advantage of newer technologies for measurement of both coating thickness and overall pipe thickness.
# Estimated Materials Service Life Chart for CSP

<table>
<thead>
<tr>
<th>CSP Material</th>
<th>Estimated Service Life</th>
<th>Site Environmental Conditions</th>
<th>Maximum FHWA Abrasion Level</th>
</tr>
</thead>
</table>
| Galvanized         | Average 50 years       | \( 6.0 \leq \text{pH} \leq 10.0 \)\(^{1}\)  
                        \( 2000 \leq r \leq 10,000 \text{ ohm-cm} \)  
                        \( > 50 \text{ ppm CaCO}_3 \)\(^{1}\) | Level 2 |
| Aluminized Type 2  | Minimum 100 years      | \( 5.0 \leq \text{pH} \leq 9.0 \)\(^{1}\)  
                        \( r > 5000 \text{ ohm-cm} \)\(^{1}\) | Level 2 |
|                    | Minimum 75 years       | \( 6 \leq \text{pH} \leq 8 \)\(^{1}\)  
                        \( r > 1500 \text{ ohm-cm} \)\(^{1}\) | Level 2 |
|                    | Minimum 75 years       | \( 5.0 \leq \text{pH} \leq 9.0 \)\(^{1}\)  
                        \( r > 1500 \text{ ohm-cm} \)\(^{1}\) | Level 2 |
|                    | Minimum 75 years       | \( 4.5 \leq \text{pH} < 9.0 \)\(^{1}\)  
                        \( r > 5000 \text{ ohm-cm} \)\(^{1}\) | Level 2 |
| Polymer Coated\(^{+}\) | Minimum 100 years     | \( 5.0 \leq \text{pH} \leq 9.0 \)\(^{1}\)  
                        \( r > 1500 \text{ ohm-cm} \)\(^{1}\) | Level 3 |
|                    | Minimum 75 years       | \( 4.0 \leq \text{pH} \leq 9.0 \)\(^{1}\)  
                        \( r \geq 750 \text{ ohm-cm} \)\(^{1}\) | Level 3 |
|                    | Minimum 50 years       | \( 3.0 \leq \text{pH} \leq 12.0 \)\(^{1}\)  
                        \( r \geq 250 \text{ ohm-cm} \)\(^{1}\) | Level 3 |

\(^{+}\)Polymer coating is 0.010 in. on each side

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\(^{1}\)Assumptions include:
- pH range for acid rain (5.5 to 6.5) and basic rain (8.5 to 9.5)
- Resistance range for soil types with varying moisture and pH conditions
- Calcium carbonate concentration for areas with limestone or dolomite

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**NCSPA**

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Ohio University Study
More sites better data
Technical Resources

- NCHRP Study 14-26 – Culvert and Storm Drain Inspection Manual
- NCSPA Video – An Explanation of the Limitations of Hand-held Coating Thickness Devices When Applied to ALT2 Coatings
Technical Resources

• Visit www.transportation.org
  • AASHTO Materials Specifications M36, M218, M245, M246, M274
  • LRFD Bridge Design (Section 12) and Construction (Section 26) Specifications

• Visit www.astm.org
  • ASTM Specifications A760, A762, A798 and A807

• Visit www.NCSPA.org to see steel in action.
  • NCSPA Corrugated Steel Pipe Design Manual
  • NCSPA Installation Guide
Member Companies

- TEE GROUP FILMS
- AK Steel
- Precoat Metals
- Steel Dynamics, Inc.
- VALFILM
- CONTECH ENGINEERED SOLUTIONS
- Lensen BRIDGE & SUPPLY
- IRONSIDE
- Cadillac Culvert, Inc.
- WORTHINGTON INDUSTRIES
- LANE
- PRD
- ACi
- ADVANCED COIL INDUSTRIES
Thank You!!!

QUESTIONS???

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