Pipe Materials & Coatings

- Galvanized Steel Pipe
- Asphalt-Coated Corrugated Steel Pipe
- ALUMINIZED STEEL™ Type 2 (ALT2)
- Polymer-Coated Corrugated Steel Pipe
- Corrugated Aluminum Pipe
What We Know…
Galvanized

The benchmark for durability

ALT2 - Multiple Layer Protection

1. **Aluminum Oxide Barrier** - Forms in hard & soft water
2. **Aluminum Layer** - Corrosion resistant / Cathodic protection
3. **Thick Alloy Layer** - Abrasion resistant / Pit arrestor
AK Steel 30 and 43 Year Reports

1982 Study
Establishes recommended environmental range
(pH = 5-9; R > 1500 Ohm-cm)
for a 50 year life for 16gage Aluminized Steel

1995 Study
75 year service life

Polymer Coated Steel
TRENCHCOAT® protective film bonds to galvanized steel both chemically and physically

TRENCHCOAT Heavy Gauge Polymer Film (10 mil)
Zinc
Steel Alloy Layers
Steel
Aluminum

The aluminum alloy sheet is an aluminum core with an added cladding layer that contains a small amount of zinc.

Service-life expectancy studies performed since the early 1960's have concluded that 16 ga. CORLIX will last 75+ years when installed in the appropriate environment.

pH 4 – 9  R >= 500 ohm.cm
What We Know

Aluminum

- CORLIX performs exceptionally well in salt water environments with R as low as 35 ohm-cm
- Pipe must be backfilled with clean, granular material

What We Know

The service life of corrugated metal pipe is influenced by these factors:

- pH
- Resistivity
- Water Chemistry
- Backfill
- Flow Velocity
- Bed Load

What Impacts CMP Durability?
What Impacts CMP Durability?

Environment

pH
A measure of the activity of hydrogen ions in a solution that indicates the level of acidity

Resistivity
A measure of how strongly a material opposes the flow of electric current. A low resistivity indicates a material that readily allows the movement of electrical current.

(water chemistry and backfill characteristics, as well)

Water/Soil Limits:

- Galvanized Steel
  - \( 6.0 \leq \text{pH} \leq 10.0 \)
  - \( 2,000 \text{ ohm-cm} < \text{Resistivity} < 8,000 \text{ ohm-cm} \)

- Aluminized Type 2
  - \( 5.0 \leq \text{pH} \leq 9.0 \)
  - \( \text{Resistivity} > 1,500 \text{ ohm-cm} \)

- Aluminum
  - \( 4.0 \leq \text{pH} \leq 9.0 \)
  - \( \text{Resistivity} > 500 \text{ ohm-cm} \)

- Polymer Coated
  - \( 3.0 \leq \text{pH} \leq 12.0 \)
  - \( \text{Resistivity} > 250 \text{ ohm-cm} \)
Galvanized Steel
Caltrans Study

- Investigated over 7,000 culverts in the 1950's (mostly small diameter).
  - Majority of culverts in the northwestern part of the state
    - Heavy rainfall
    - Mountainous terrain
    - Moderately abrasive bedloads
    - Tested soil and water chemistries

- Generated an empirical chart to predict “time to first perforation”.
  - First perforation defined as “service life”
  - Represents about 12% - 13% metal loss
  - Found correlation between pH and resistivity
  - Still in use in California today.
Galvanized Steel
U.S. Dept. of Weights & Measures

- Refined the Caltrans study - 1983
  - The Caltrans method underestimated the actual service life of most culverts.
    - Culverts with less than “moderate” abrasion
    - Culverts with intermittent flow
    - Culverts with lower velocity flows
Invert metal loss of 25% more accurately predicts service life
  • Maintain a factor of safety of at least 1.5 for cross-sectional area.
  • Adequate invert metal left to begin maintenance.
  • Still conservative for soilside corrosion.

Effort resulted in development of the A.I.S.I chart.

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Developed a rational method to determine which service life chart is appropriate - 1988
  • Type of flow: gravity or pressure?
  • Type of bedding and backfill material?
  • Anticipated abrasion level?
  • Invert protection?

See flow chart.
Abrasion

Abrasion is a function of flow velocity AND bed load. In the absence of bed load, abrasion is **not** a factor.

FHWA abrasion guidelines:

<table>
<thead>
<tr>
<th>Abrasion Level</th>
<th>Abrasion Condition</th>
<th>Bed Load</th>
<th>Flow Velocity (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Non – Abrasive</td>
<td>None</td>
<td>Low</td>
</tr>
<tr>
<td>Level 2</td>
<td>Low Abrasive</td>
<td>Minor (sand)</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>Level 3</td>
<td>Moderate Abrasive</td>
<td>Moderate (sand &amp; gravel)</td>
<td>5 - 15</td>
</tr>
<tr>
<td>Level 4</td>
<td>Severe Abrasive</td>
<td>Heavy (sand, gravel &amp; rock)</td>
<td>&gt; 15</td>
</tr>
</tbody>
</table>

Abrasion Considerations

Abrasion is a function of the characteristics of the bedload (size and hardness of aggregates), flow velocity, and frequency of flow.
If abrasion is not considered during initial design, then inspection and maintenance are crucial to prevent catastrophic damage to the invert of the culvert.

This CSP culvert had a reinforced concrete paved invert placed during installation in order to accommodate abrasive flows up to 45 fps.
Table 1 – Recommended Environments

<table>
<thead>
<tr>
<th>Material Type</th>
<th>SO2 and Moisture (%)</th>
<th>Resistance (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanized Steel*</td>
<td>0-2000</td>
<td>8000</td>
</tr>
<tr>
<td>Alumined Steel Type 2 (ATD)</td>
<td>1500</td>
<td>N/A</td>
</tr>
<tr>
<td>Polymer Coated</td>
<td>1500</td>
<td>N/A</td>
</tr>
<tr>
<td>Aluminum Alloy</td>
<td>300</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Appropriate pH range for Galvanized Steel is 6.0 to 10.

Table 2 – FWA/AS Abraision Guidelines

<table>
<thead>
<tr>
<th>Abrasion Level</th>
<th>Absorption Condition</th>
<th>Bed Load</th>
<th>Flow Velocity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>Low Abrasion</td>
<td>Heavy</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>Moderate Abrasion</td>
<td>Heavy</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>Severe Abrasion</td>
<td>Heavy</td>
<td>0.5</td>
</tr>
</tbody>
</table>

For applications other than abrasion or erosion conditions above Abrasion Level 2, please contact your Contech Sales Representative for additional information.

Table 3 – Brochure Product Usage Guide

<table>
<thead>
<tr>
<th>Application</th>
<th>Design Service Life</th>
<th>Abrasion Level 1 &amp; 2</th>
<th>Abrasion Level 3 &amp; 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanized Steel</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Galvanized and Asphalt Coated</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Ductile Cast Iron</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Alumined Type 3 (ATD)</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Polymer Coated</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Aluminum Alloy</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

For applications other than abrasion or erosion conditions above Abrasion Level 2, please contact your Contech Sales Representative for additional information.

1. Based on Table 1 – Recommended Environments.
2. DMT, Ductile Iron, and ISO 16966 are registered trademarks of the American Iron and Steel Institute.
3. The design service life is based on a pH of 7.0 and moisture content of 15%.
4. Abrasion resistance is based on a pH of 7.0 and moisture content of 15%.
5. Design service life is based on a pH of 7.0 and moisture content of 15%.
6. Abrasion resistance is based on a pH of 7.0 and moisture content of 15%.
7. Abrasion resistance is based on a pH of 7.0 and moisture content of 15%.
8. Abrasion resistance is based on a pH of 7.0 and moisture content of 15%.
9. Abrasion resistance is based on a pH of 7.0 and moisture content of 15%.
10. Abrasion resistance is based on a pH of 7.0 and moisture content of 15%.

Kansas Dam Safety Conference
March 11, 2020

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