Corrosion Protection of the 21st Century

* "ZAM" is a registered trademark of NIPPON STEEL CORPORATION in Japan (Reg. No. 4637134), the United States (Reg. No. 3254099) and other countries and regions. "ZAM" is the brand name of high corrosion resistance hot-dip coated steel sheets developed by NIPPON STEEL CORPORATION. © 2019 Wheeling-Nippon Steel All Rights Reserved.
Highly Corrosion Resistant Coated Steel

Chemical Treatment

Zn-Al 6%-Mg 3% Coating Layer

Steel
Corrosion Mechanism Of ZAM®

- Mg & Al form a fine, tight protective film

Thick Zinc-Aluminum based film containing Magnesium.

Corrosion of coating layer suppressed

Excellent Corrosion resistance
Corrosion Resistance of ZAM®

- ZAM® Coating Layer
  - Steel Base

- GI Coating Layer
  - Steel Base

Progress of corrosion:

- White rust composed primarily of zinc oxide
- Zinc and zinc-aluminum based protective surface film containing magnesium

Red Rust
ZAM® fine dense corrosion products

<table>
<thead>
<tr>
<th>GL (Zn)</th>
<th>Galfan(Zn-5%Al)</th>
<th>ZAM® (Zn-6%Al-3%Mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="GL (Zn) image" /></td>
<td><img src="image2" alt="Galfan image" /></td>
<td><img src="image3" alt="ZAM® image" /></td>
</tr>
<tr>
<td><strong>Appearance of corrosion products after 4hrs salt spray test</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **GL (Zn)**: Porous & coarse
- **Galfan(Zn-5%Al)**: Porous
- **ZAM® (Zn-6%Al-3%Mg)**: Fine & compact corrosion products

**Coating layer**

- Zn, Zn-Al basic corrosion products containing Mg
- Zn/Al/MgZn₂

**Coating mass**: 0.30 oz/ft²
ZAM® Corrosion on Flat Side

Red rust occurrence after salt spray test (untreated)

<table>
<thead>
<tr>
<th>ZAM®</th>
<th>Galvanized</th>
<th>Zn-5%Al</th>
<th>55%Al-Zn</th>
</tr>
</thead>
</table>

*2,500 Hours of Salt Spray (Coating Weight: .30 oz/ft² on one side)
Corrosion Mechanism on Cut Edge

- **ZAM® coating layer**
- **Substrate**
- **Initial exposure period**
- **Long exposure period**
- **Enlarged picture**
  - Fine zinc-based Mg film flows over cut edge
  - Protective film changes to gray then gray-black
# ZAM® Cut Edge Corrosion Resistance

<table>
<thead>
<tr>
<th></th>
<th>1000h</th>
<th>4000h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZAM®</strong></td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td><strong>GI</strong></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td><strong>Zn-5%Al</strong></td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
</tr>
<tr>
<td><strong>55%Al-Zn</strong></td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
</tr>
</tbody>
</table>

*Appearance of cut edge after salt spray test (Gauge: 0.091”; Coating .30 oz/ft² on one side)*
ZAM® Replaces Post Hot Dip GI

ZAM® Eliminates Process = Cost Reduction
ZAM® Best Applications & Target Markets

Best Applications:
- Heavy GI coating → ZAM®
- Post dipped GI → ZAM®
- Heavy gauge GL → ZAM®
- Stainless steel → ZAM®
- Environmental → ZAM®

Nippon Steel Examples:
- Construction framing
- Green house tubing
- Solar racking
- Automotive parts/covers
- Electrical panel/cabinet
- A/C panels / base tray
- Agriculture building

Targets:
- Agriculture Related
- Animal confinement
- Swimming Pool Walls
- Solar Racking (UL2703)
- Architectural Panels
- Highway Construction
- Fence / Railing
- Automotive
Benefits of ZAM®

• Longer life than other coatings
• Cut edge rust protection
• Thinner coating yet more protection
• Excellent in severe environments
• Eliminates need for post dip galvanizing
• Superior formability – harder coating
• Cost savings through less maintenance
• Bridge between stainless and heavy galvanized