Use Of High-Performance A710 Grade B Steel in Construction of Lake Villa, IL Bridge

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Presentation

• Properties of A710 Grade B Steel
• Steel for Lake Villa Bridge
• Fabrication of Girders
• Bridge Construction
A710 Grade B steel is Cu-precipitation strengthened ferritic steel:

- Hot-rolled, air-cooled --- no quenching, no aging, no thermo-mechanical-controlled processing steel plates of any size produced by any steel mill
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- Copper strength, fracture toughness, weatherability/ corrosion resistance
- No chromium or molybdenum lower cost, health advantages
Steel Composition*

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cu</th>
<th>Si</th>
<th>Ni</th>
<th>Cr</th>
<th>Mo</th>
<th>Nb</th>
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<tbody>
<tr>
<td></td>
<td>0.07</td>
<td>0.69</td>
<td>0.009</td>
<td>0.001</td>
<td>1.34</td>
<td>0.40</td>
<td>0.90</td>
<td>0.05</td>
<td>0.05</td>
<td>0.035</td>
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* 5 heats of steel produced at ISG (now Mittal Steel USA) for Lake Villa Bridge
Precipitates in Cu-Precipitation-Strengthened Steel

1.36 Cu, 0.85 Ni, 0.45 Mn steel, 0.06 C
Solution treated and aged to maximum strength
Red = Cu, Green = Ni. Fe not shown
Box dimensions $14 \times 14 \times 101$ nm$^3$

Courtesy of Dr. D. Isheim
Corrosion Evaluation

Accelerated Corrosion Test (Automotive SAE J2334 Standard) Performed at Bethlehem Steel Company (now Mittal Steel)

PAINTED STEEL PANELS AFTER 3-WEEK, 35°C EXPOSURE IN SALT-FOG CHAMBER
Welding

- Steel was easily welded without pre-heat or post-heat with heat input as high as 90 kJ/inch) ----no brittle heat-affected zone formed ---no cracking
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• Duplicate G-BOP tests performed at US Steel Company (53 kJ/inch) --- no cracks in the welds or base plates
Machinability

Tests performed by Machining Research Inc. (contracted by IDOT) on A36, A709 HPS70W and A710 Grade B steels.

Conclusion: “The A710 steel consistently showed the best machinability”
Lake-Villa Bridge

Bridge Location
Bridge Specifications

- Continuous span length of 430.6 ft
- Only two new piers (before eight piers)
- Plate girders \(-\frac{1}{2}''\) thick web plate, with 1.125” x 16” bottom flanges, and 0.875” x 16” top flanges in the composite areas
- In sections over piers the top and bottom flanges are 1.875” x 16”
- Submerged arc welding (Lincoln LA-75 (AWS ENi1K), 3/32” diameter electrode, with a neutral Lincolnweld 960 flux)
Strength

![Graph showing the relationship between plate thickness and stress. The graph includes data points for Yield Stress (blue triangles) and Ultimate Tensile Strength (red circles). The x-axis represents Plate Thickness in inches, ranging from 0 to 2 inches. The y-axis represents Stress in Ksi, ranging from 60 to 110 ksi.]

- **Stress, Ksi**
  - 110
  - 100
  - 90
  - 80
  - 70
  - 60

- **Plate Thickness, in**
  - 0
  - 0.5
  - 1
  - 1.5
  - 2

Legend:
- ▲ Yield Stress
- ⬜ UTS
V-notch Charpy Fracture Energy at -10°F
Effect of Heat-Straightening on Fracture Toughness

<table>
<thead>
<tr>
<th></th>
<th>Charpy (ft-lbs) at -10°F</th>
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<tbody>
<tr>
<td>As Received</td>
<td>169</td>
</tr>
<tr>
<td>Reheated at 800°F</td>
<td>165</td>
</tr>
<tr>
<td>Reheated at 950°F</td>
<td>155</td>
</tr>
<tr>
<td>Reheated at 1100°F</td>
<td>152</td>
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<tr>
<td>ASTM A710 Requirement</td>
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Industrial Steel Construction, Gary, Indiana
Second Part
Acknowledgement

- Shrikant Bhat (Inland, now Mittal Steel)
- Graef Schloemer and Assoc., Chicago
- ISG (now Mittal Steel) --- Alex Wilson
- Industrial Steel Construction, Gary, IN --- Chris Crosby
- IDOT --- Christopher Hahin
- Dunnet Bay Inc.
Super-Cryogenic-Tough

NUCu-60 Steel

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Yield (Ksi)</td>
<td>60</td>
</tr>
<tr>
<td>UTS (Ksi)</td>
<td>80</td>
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<tr>
<td>Elongation (%)</td>
<td>27</td>
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</table>

<table>
<thead>
<tr>
<th>Temperature, °F</th>
<th>Charpy Impact Energy Absorption (ft-lbs.)</th>
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<tbody>
<tr>
<td>75</td>
<td>&gt;264</td>
</tr>
<tr>
<td>10</td>
<td>&gt;264</td>
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<tr>
<td>-40</td>
<td>&gt;264</td>
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<tr>
<td>-80</td>
<td>&gt;264</td>
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