Corrosion Resistant Reinforcing Steel (CRR)

Virginia DOT Workshop – Charlottesville, VA

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• IIM S&B – 81 CRR
• IIM S&B – 81.7 CRR
• First Released on June 18, 2008
  – After extended research by Research Council.
  – Three types – ASTM1035, Stainless Solid & Clad

• Revised 7 times as of December 13, 2016
  – Clad is taken out – No Producers
  – New ASSHTO tests
  – New players - Clad producers in US
• Two Types of CRR steels
  – Low-carbon, Chromium ASTM A1035/A1035 M
    • Minimum Chromium Content of 9.2%
  – Solid Stainless Steel AASHTO MP18M/MP18-15

• Three Classes
  – Class I - ASTM A1035/A1035 M, UNS S24100
  – Class II - AASHTO MP18M/MP18-15, UNS S32101
  – Class III - AASHTO MP18M/MP18-15, UNS S24000, S30400, S31603, S31653, S31803 & S32304
• Substitution
  - CRR Class II or Class III may be substituted for Class I
  - CRR Class III may be substituted for Class II
  - CRR with a lower class designation than specified shall not be used

Clad – Not Allowed

Class I

Class II

Class III
• Usage based on Functional Classification

<table>
<thead>
<tr>
<th>Functional Classification</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Rural Principal Arterial</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>Rural Minor Arterial</td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>Rural Collector Road</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rural Local Road</td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>Urban Principal Arterial</td>
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<td>X</td>
</tr>
<tr>
<td>Urban Minor Arterial</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Urban Collector Street</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Urban Local Street</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>All Pedestrian Bridges</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
• Usage based on Functional Classification
  – All Reinforcement
    • Concrete Decks
    • Medians and Parapets
    • Approach Slabs
    • Moment Slabs
    • Integral Backwall
    • Concrete Diaphragms
    • Prestressed Concrete Slabs
    • Reinforced Concrete Slabs
• **CRR Steel Class I**
  - All reinforcement
    - Substructure units in tidal waters
    - Footings in integral abutments
    - Box culverts (CIP and precast) with 0 to 2 foot fill
  - All neat reinforcement including footing bars extending into neat concrete in the substructure units
    - Substructure units located within 22 feet from the edge of the traveled way
    - Portions of retaining walls located within 22 feet from the edge of the traveled way (splash zone):
**Design**

- Based on 60 Ksi for all 3 Classes of CRR
  - Easy Substitution
- Sizes
  - Availability of bars sizes (#3 through #11) and bar lengths

<table>
<thead>
<tr>
<th></th>
<th>CRR Low Carbon/Chromium</th>
<th>CRR Solid Stainless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar Sizes</td>
<td>All</td>
<td>ALL</td>
</tr>
<tr>
<td>Bar Lengths</td>
<td>40 feet – all sizes</td>
<td>40 feet – all sizes</td>
</tr>
<tr>
<td></td>
<td>60 feet all except #3</td>
<td>60 feet – all sizes</td>
</tr>
</tbody>
</table>
IIM S&B – 81.7 CRR

• Splash Zones
  – MSE walls
  – Depressed highways
CRR bars

• Storage
  - Keep free from oil, dirt and mud
  - Should not be stored directly on the ground
  - Deleterious materials should be removed from the bars before placing concrete
  - Surface rust of mill scale for Class I (MMFX-2) bars should not be cause for rejection

• Cutting Bars
  - Cut by shearing
  - Cut with a fluid cooled saw
  - Torch cutting is never permitted
CRR bars

• Bending Bars
  – Cold bend
  – Prescribed min. diameter pin
  – No bending or straightening that will damage material
  – Heating material to bend is never allowed

• Welding
  – Welding of CRR bars is not permitted
Prestress Strands - Piles

• Comparison of Properties

<table>
<thead>
<tr>
<th>Strand Properties</th>
<th>ASTM A416</th>
<th>CFRP</th>
<th>Stainless Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength (ksi)</td>
<td>270</td>
<td>338</td>
<td>250</td>
</tr>
<tr>
<td>Elastic Modulus (ksi)</td>
<td>28,600</td>
<td>22,500</td>
<td>24,500</td>
</tr>
<tr>
<td>Elongation at break (%)</td>
<td>3.5</td>
<td>1.7</td>
<td>1.47</td>
</tr>
</tbody>
</table>

CFRP: Carbon Fiber Reinforced Polymer
Prestress Strands - Piles

• Strands in Piles
  – As of Dec, 2016
    • CFRP Standard BPP-3
    • Stainless Steel BPP-2
    • East of the Red line
Prestress Strands - Piles

- Nimmo Parkway
  - Bent 12 and Bent 13
• Finding in the public interest
  – FHWA approved
    • Use of Carbon Fiber Composite Cable (CFCC) in piles
  – Based on 100-year service life
  – Use in high salt, high corrosion, coastal areas, high salinity and areas where traffic volumes are so high that access for repairs is a constraint.
  – 5 Year trial period for projects in PE phase, Dec 31, 2021
Prestress Strands - Beams

• Strands in Beams
  – Route 49 over Aaron’s Creek
    • 4 beams per span
    • 45” modified bulb tee girders
    • 82-ft length beam
Questions?

Implementation Leads:

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- Anne-Marie Langlois, COWI North America, amln@cowi.com

Resource: AASHTO’s R19A Product Page

- http://shrp2.transportation.org/Pages/ServiceLifeDesignforBridges.aspx