A1035-CS IN THE NEW NICE - MIDDLETON BRIDGE Project for Sustainable Bridge Construction

Date: 10.24.2023
The new Nice Middleton Bridge

- Why a new bridge?
  - replace the 82-year-old 1.9 mile-long, two-lane bridge over the Potomac River between Maryland and Virginia
- New bridge rises 135 ft above the Potomac and provides 4 lanes of travel
- The largest MDTA bridge project to date
- Design-build delivery method
Designed and built in less than 3 years, the new Nice Middleton Bridge over the Potomac River opened to traffic on October 12, 2022.
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.
The new Nice Middleton Bridge

How does the new bridge compare with the old bridge?

- The new bridge is 1.9 miles long with four lanes of travel, replacing the old bridge’s two 11-foot-wide lanes
- Barrier separated median between northbound and southbound lanes, 2 ft shoulders and other safety standards improvements
- All-electronic tolling (AET) at highway speeds
- 135 ft above the Potomac River to allow passage of tall vessels
The existing bridge to be demolished and materials from the old bridge will be deposited in the Chesapeake Bay to supplement an artificial fish reef.
Nice Middleton Bridge Project profile

The largest project with A1035-CS in Maryland

- **Owner**: MDTA
- **Prime Contractor**: Skanska/Corman/McLean (SCM) joint venture, Newburg, MD
- **EOR**: AECOM, Richmond, VA
- **Steel fabricator**: Commercial Metals Company, King George, VA
- **Precaster**: Coastal Precast Systems, Cape Charles, VA
- **CRR Steel**: A1035-CS Qty: 3,600 Tons
- **Budget**: $463 million
- **Design-Build Timeline**: 2020 to 2022
Construction Schedule & Use of A1035-CS Reinforcement
Nice/Middleton Bridge Project
MDTA construction schedule
Nice/Middleton Bridge Project

Rebar specification for the largest bridge project with A1035-CS in Maryland

- A615, A775 and A1035-CS reinforcement was utilized;
- A1035-CS reinforcing used in these locations per RFP to achieve 100 years service life:
  - approach slabs
  - abutment backwalls
  - deck slab
  - parapets & median barriers
- No stainless steel utilized
- 60 ksi yield strength design

7.1.4.2 Reinforcement

A) One or a combination of the following types of reinforcing shall be utilized at the locations described and per the requirements in Sections B and C.

1) Epoxy coated steel reinforcing and WWF conforming to Section 917.02 of the 2018 SHA Standard Specifications.
2) Low-carbon, chromium, steel reinforcing bars conforming to ASTM A1035/A1035M Alloy Type 1035 CS with a minimum chromium content of 9.2%.

B) Low-carbon, chromium or solid stainless reinforcement types in Sections 2) or 3) from Section A) shall be utilized at the following locations:

1) Concrete deck slabs (including bolster): All reinforcement.
2) Parapets, rails, median barriers and terminal walls: All reinforcement including that which extends into the concrete deck slab, approach slab, retaining wall or moment slab.
3) Approach slabs (including sleeper slabs) and retaining walls.
4) Moment slabs: All reinforcement.
Nice/Middleton Bridge Overall Design

Combination of prestressed concrete girders in the low-level and high-level approach spans.

- The design by Aecom is based a combination of prestressed concrete girders in the low-level and high-level approach spans.
- Old bridge in the background in gray.
Nice/Middleton Bridge Project

Construction Sequence 2: Approach Roadways

• 60,000 yard$^3$ of soil for embankments.
• Erosion and sedimentation control measures prior to construction
• Two temporary trestles built out onto the river. The MD trestle extends 240 feet from the shore into the river, while in Virginia it reaches 360 feet into the river.
• The A1035-CS rebar was used in the approach slabs (including sleeper slabs) and retaining walls.
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.

May 2022 Maryland Approach looking West
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.
Nice/Middleton Bridge Superstructure

Construction Sequence 5: prestressed concrete girders and CIP deck

- 79-in.-deep Maryland PCEF girders, spacing 10’ 7” centers
- 10,000 psi concrete design for girders
- 8½” thick CIP reinforced concrete deck with ½” integral wearing surface. Synthetic fibers used for crack control
- A1035-CS used in the deck, parapets, rails, barriers and terminal walls.
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.
Opening Ceremony

Nice/Middleton Bridge Project

- On October 12, 2022 Maryland Delivers New Nice-Middleton Bridge on budget and three months ahead of schedule, replacing 82-year old span
- New Bridge doubles capacity, improves safety, and enhances emergency response activities
- CMC is extremely proud to be part of this landmark project.
A1035-CS Steel Facts
How is A1035 Made?

What Makes A1035-CS Different From Other Rebar?

Martensitic - Austenitic microstructure provides:
- Corrosion Resistance
- High Strength with Ductility

Controlled Melting Process

Controlled Rolling Process
ASTM A1035-CS vs ASTM A955

Stress-strain comparison between ChromX 9100 and Stainless steel rebars tested in tension.

According to ASTM:
Yield strengths determined by 0.2% offset method.

Actual T/Y = 1.42 > 1.35
Actual Tensile Strength = 168 ksi
Actual Yield Strength = 118 ksi
# Tensile Requirements of ASTM A955 vs A1035

**ASTM A955-20c vs ASTM A1035-20**

### ASTM A955

<table>
<thead>
<tr>
<th>Tensile Requirements</th>
<th>Grade 60 [420]</th>
<th>Grade 75 [520]</th>
<th>Grade 80 [550]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength, min, psi</td>
<td>90 000 [620]</td>
<td>100 000 [690]</td>
<td>100 000 [690]</td>
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<tr>
<td>Yield strength, min, psi [MPa]</td>
<td>60 000 [420]</td>
<td>75 000 [520]</td>
<td>80 000 [550]</td>
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<tr>
<td>Ratio of actual tensile strength to actual yield strength, min</td>
<td>1.20</td>
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<td>1.20</td>
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<tr>
<td>Elongation in 8 in. [200 mm], min, %</td>
<td>20</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Bar designation no. 3, 4, 5 [10, 13, 16]</td>
<td>20</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>6 [19]</td>
<td>20</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>7, 8, 9, 10, 11, 14, 18 [22, 25, 29, 32, 36, 43, 57]</td>
<td>20</td>
<td>20</td>
<td>16</td>
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</table>

*Consult with the manufacturer for availability of grades and bar sizes.*

### ChromX 9100ASTM A1035 CS

<table>
<thead>
<tr>
<th>Tensile Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>Tensile strength, min, psi [MPa]</td>
</tr>
<tr>
<td>Yield strength (0.2 % offset), min [MPa]</td>
</tr>
<tr>
<td>Elongation in 8 in. [200 mm], mi Bar Designation No. 3 through 11 [10 through 36]</td>
</tr>
<tr>
<td>14, 18, 20 [43, 57, 64]</td>
</tr>
</tbody>
</table>

**T/Y ratio > 1.25**
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.

Steel fabricator: Commercial Metals Company, King George, VA
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.

Photo: CMC Fabrication King George, VA

Deck reinforcement before concrete pour
Photo: CMC Fabrication King George, VA
The existing bridge will be demolished once the new bridge opens, and materials from the old bridge will be deposited in the Chesapeake Bay to create an artificial fish reef.
The case for A1035-CS reinforcement

Corrosion plan developed by:

SIVA CORROSION SERVICES, INC.
Materials, Corrosion, and NDT Specialists
Fib 34 Service Life Model – Key Parameters

• Concrete Cover
• Chloride Loading
• Concrete Mix (Resistance to Chlorides)
• Rebar Type (Corrosion Threshold)
  • Need to balance constraints of each parameter to optimize performance and cost
Selecting Appropriate Parameter Inputs

• Past Performance:
  • Measure chloride contamination at/near the new bridge site
  • Measure typical rebar concrete diffusion
  • Need statistical data

• Design Requirements:
  • Minimum cover
  • Cracking control
Life Cycle Cost for Each Rebar Type

• Compared the LCC over 75 years for four reinforcement types.

• Same life could be achieved with other means (e.g., greater cover), but we wanted to keep the standard details as close to original.

• LCC – Based on data from Maryland. Will be different for other states.
**ASTM A955 / A1035 Chemical Composition**

<table>
<thead>
<tr>
<th>UNS Designation</th>
<th>Type</th>
<th>Carbon</th>
<th>Manganese</th>
<th>Phosphorus</th>
<th>Sulfur</th>
<th>Silicon</th>
<th>Chromium</th>
<th>Nickel</th>
<th>Molybdenum</th>
<th>Nitrogen</th>
<th>Other Elements</th>
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<tbody>
<tr>
<td>S24000</td>
<td>XM-29</td>
<td>0.08</td>
<td>11.5-14.5</td>
<td>0.050</td>
<td>0.030</td>
<td>1.00</td>
<td>17.6-18.0</td>
<td>2.3-3.7</td>
<td>....</td>
<td>0.20-0.45</td>
<td>....</td>
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<tr>
<td>S24100</td>
<td>XM-29</td>
<td>0.15</td>
<td>11.0-14.0</td>
<td>0.045</td>
<td>0.030</td>
<td>1.00</td>
<td>16.6-18.0</td>
<td>0.50-2.50</td>
<td>....</td>
<td>0.20-0.45</td>
<td>....</td>
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<tr>
<td>S31653</td>
<td>316LN</td>
<td>0.030</td>
<td>2.00</td>
<td>0.045</td>
<td>0.030</td>
<td>1.00</td>
<td>16.6-18.0</td>
<td>0.50-2.50</td>
<td>....</td>
<td>0.20-0.45</td>
<td>....</td>
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**Austenitic-Ferritic (Duplex) Grades**

<table>
<thead>
<tr>
<th>UNS Designation</th>
<th>Type</th>
<th>Carbon</th>
<th>Manganese</th>
<th>Phosphorus</th>
<th>Sulfur</th>
<th>Silicon</th>
<th>Chromium</th>
<th>Nickel</th>
<th>Molybdenum</th>
<th>Nitrogen</th>
<th>Other Elements</th>
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<tbody>
<tr>
<td>S31803</td>
<td>2205</td>
<td>0.08</td>
<td>2.00</td>
<td>0.030</td>
<td>0.020</td>
<td>1.00</td>
<td>21.0-22.0</td>
<td>4.5-6.5</td>
<td>2.5-3.5</td>
<td>0.06-0.20</td>
<td>....</td>
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<tr>
<td>S32101</td>
<td>....</td>
<td>0.040</td>
<td>4.0-6.0</td>
<td>0.040</td>
<td>0.030</td>
<td>1.00</td>
<td>21.0-22.0</td>
<td>1.55-1.70</td>
<td>0.10-0.18</td>
<td>0.20-0.25</td>
<td>Cu 0.10-0.80</td>
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<tr>
<td>S32205</td>
<td>2205</td>
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<td>2.00</td>
<td>0.030</td>
<td>0.020</td>
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<td>22.0-23.0</td>
<td>4.5-6.5</td>
<td>3.0-3.5</td>
<td>0.14-0.20</td>
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<tr>
<td>S32304</td>
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<td>2.50</td>
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<td>0.030</td>
<td>1.00</td>
<td>21.5-24.5</td>
<td>3.0-5.5</td>
<td>0.05-0.60</td>
<td>0.05-0.20</td>
<td>Cu 0.05-0.60</td>
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</table>

**TABLE 2 Chemical Compositions of Alloy Type**

<table>
<thead>
<tr>
<th>Alloy Type</th>
<th>Carbon</th>
<th>Chromium</th>
<th>Manganese</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Sulfur</th>
<th>Silicon</th>
</tr>
</thead>
<tbody>
<tr>
<td>1035 CL</td>
<td>0.3</td>
<td>2.0-3.9</td>
<td>1.5</td>
<td>0.06</td>
<td>0.035</td>
<td>0.045</td>
<td>0.5</td>
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<tr>
<td>1035 CM</td>
<td>0.2</td>
<td>4.0-7.9</td>
<td>1.5</td>
<td>0.05</td>
<td>0.035</td>
<td>0.045</td>
<td>0.5</td>
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<tr>
<td>1035 GS</td>
<td>0.15</td>
<td>8.0-10.9</td>
<td>1.5</td>
<td>0.05</td>
<td>0.035</td>
<td>0.045</td>
<td>0.5</td>
</tr>
</tbody>
</table>

| A Maximum unless range is indicated; percentages refer to weight (mass) percentages.|

**Price variability dependent on special alloys and volumes**
## CMC Performance Reinforcing Steel

<table>
<thead>
<tr>
<th>A1035 Coiled Rebar *</th>
<th>Straight Rebar</th>
<th>Smooth Rounds &amp; Dowels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar size #3* - #6</td>
<td>40', 60' standard</td>
<td>¾” to 2½” diameter</td>
</tr>
<tr>
<td>(10 mm – 19 mm)</td>
<td>Custom lengths available</td>
<td>Dowel lengths 18”, 24” &amp; 36”</td>
</tr>
<tr>
<td>Coil weight 4500 lbs/2 mt.</td>
<td>Bar size #3* - #18</td>
<td>Custom lengths upon inquiry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Available as A1035</td>
</tr>
</tbody>
</table>
CMC Performance Reinforcing Steel

**Rebar Couplers**
Different designs, types and sizes manufactured by:
- Barsplice: [www.barssplice.com](http://www.barssplice.com)
- nVent: [www.erico.com/lenton.asp](http://www.erico.com/lenton.asp)
- CMC/MMI: [www.cmcmmi.com](http://www.cmcmmi.com)

**nVent Lenton Coupler**
A32K made of A1035 steel
100 ksi
Galvanized

**Tru-Splice Coupler**
A1035 steel
100 ksi
Galvanized

A1035 rebar can be threaded and can be turned into headed terminator
Acknowledgements

Special thanks for the following individuals, whose contributions made this paper possible

1. William Pines, Executive Director at Maryland Transportation Authority
2. Brian Wolfe, Director of Project Development at Maryland Transportation Authority
3. Ken Butler, Senior Vice President at AECOM
4. Eric Nelson, Project Manager at AECOM
5. Siva Venugopalan at Siva Corrosion Services
6. Tom Russo, National Technical Product Manager at COMMERCIAL METALS COMPANY
7. Brett H Parker, Area Manager Fabrication VA/NJ at COMMERCIAL METALS COMPANY
References


2. Design information provided by Ken Butler and Eric Nelson at AECOM

3. ASPIRE Spring 2023. New Potomac River Crossing Replaces 82-Year-Old Structure by Ken Butler, AECOM

4. New Nice/Middleton Bridge Corrosion plan by Siva Venugopalan, SIVA CORROSION SERVICES.
THANK YOU!

Stop by our table #3 to learn more about this project.

Hans Geber | Product Technical Manager, Performance Reinforcing Steel
it’s what’s inside that counts