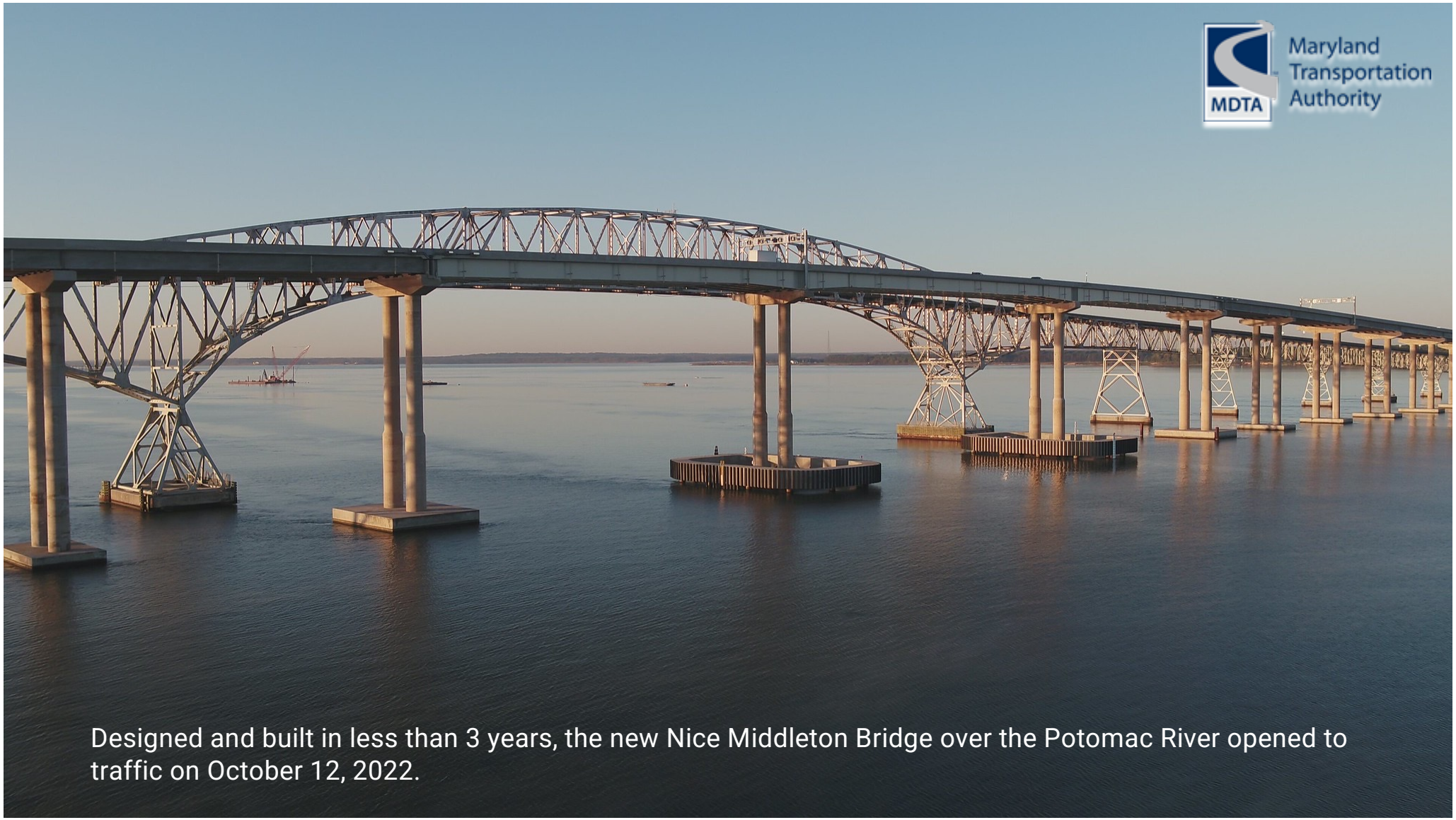
A1035-CS IN THE NEW NICE - MIDDLETON BRIDGE Project for Sustainable Bridge Construction

Date: 10.24.2023

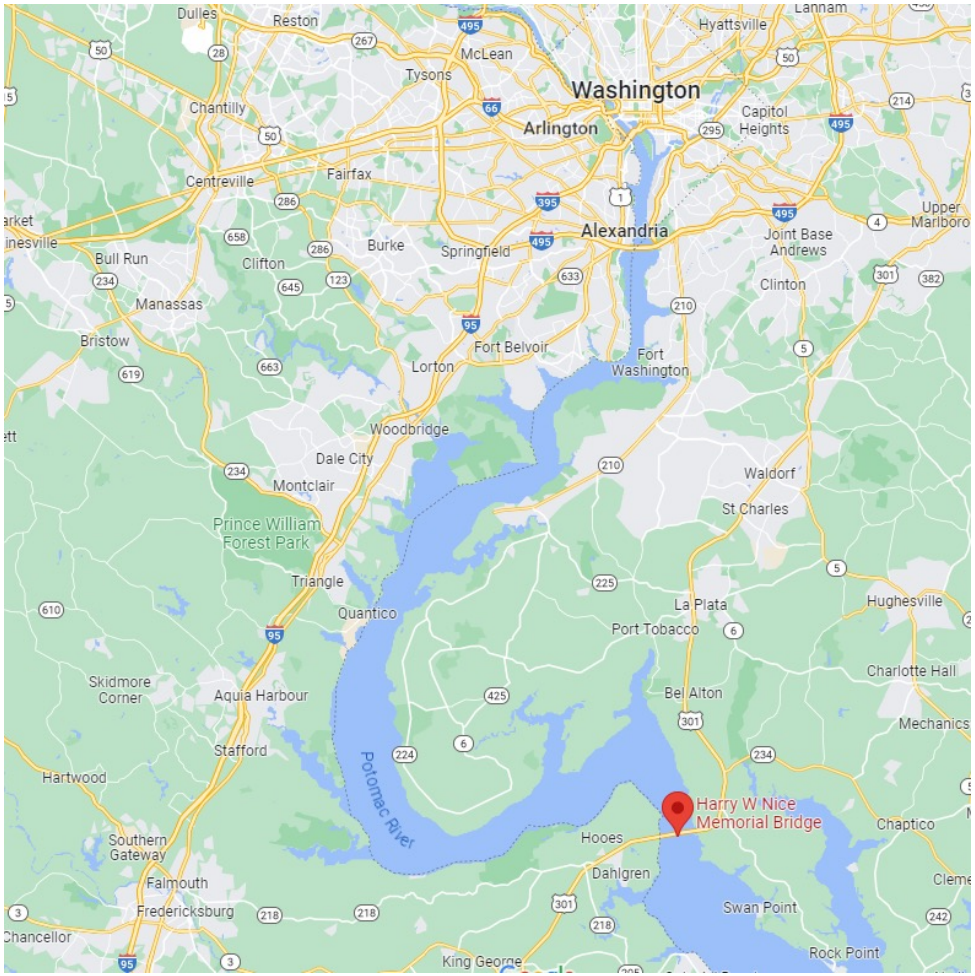
The new Nice Middleton Bridge

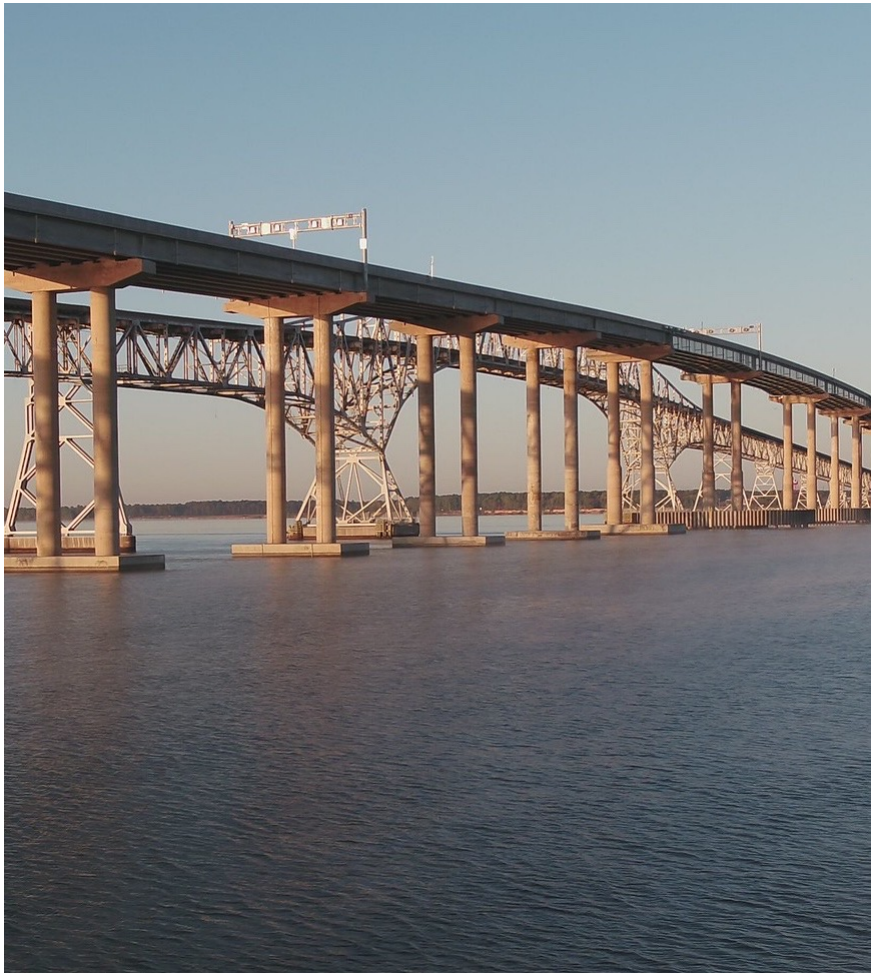
Maryland Transportation Authority
MDTA

- 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.


Dulles
Reston
Hyattsville
McLean
Tysons
Washington
Chantilly
Arlington
Capitol Heights
Centreville
Fairfax
Alexandria
Upper Marlboro
Joint Base Andrews
Bull Run
Clifton
Burke
Springfield
Clinton
Manassas
Bristow
Fort Belvoir
Lorton
Fort Washington
Woodbridge
Dale City
Montclair
Waldorf
St Charles
Prince William Forest Park
Triangle
Quantico
La Plata
Hughesville
Port Tobacco
Skidmore Corner
Aquia Harbour
Charlotte Hall
Bel Alton
Mechanics
Stafford
Hartwood
Potomac River
Harry W Nice Memorial Bridge
Chaptico
Southern Gateway
Hooes
Dahlgren
Falmouth
Fredericksburg
Swan Point
Chancellor
King George
Rock Point

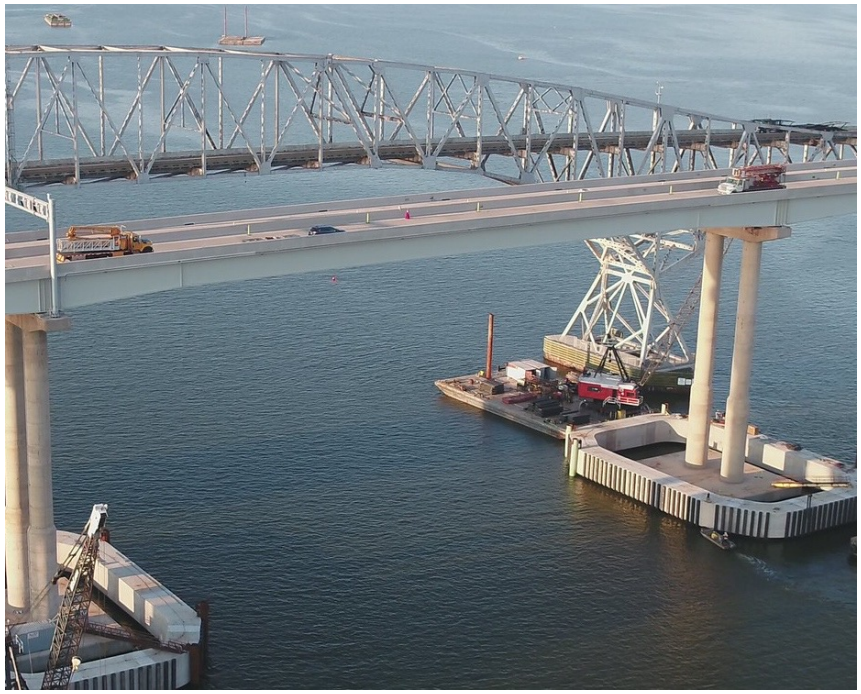


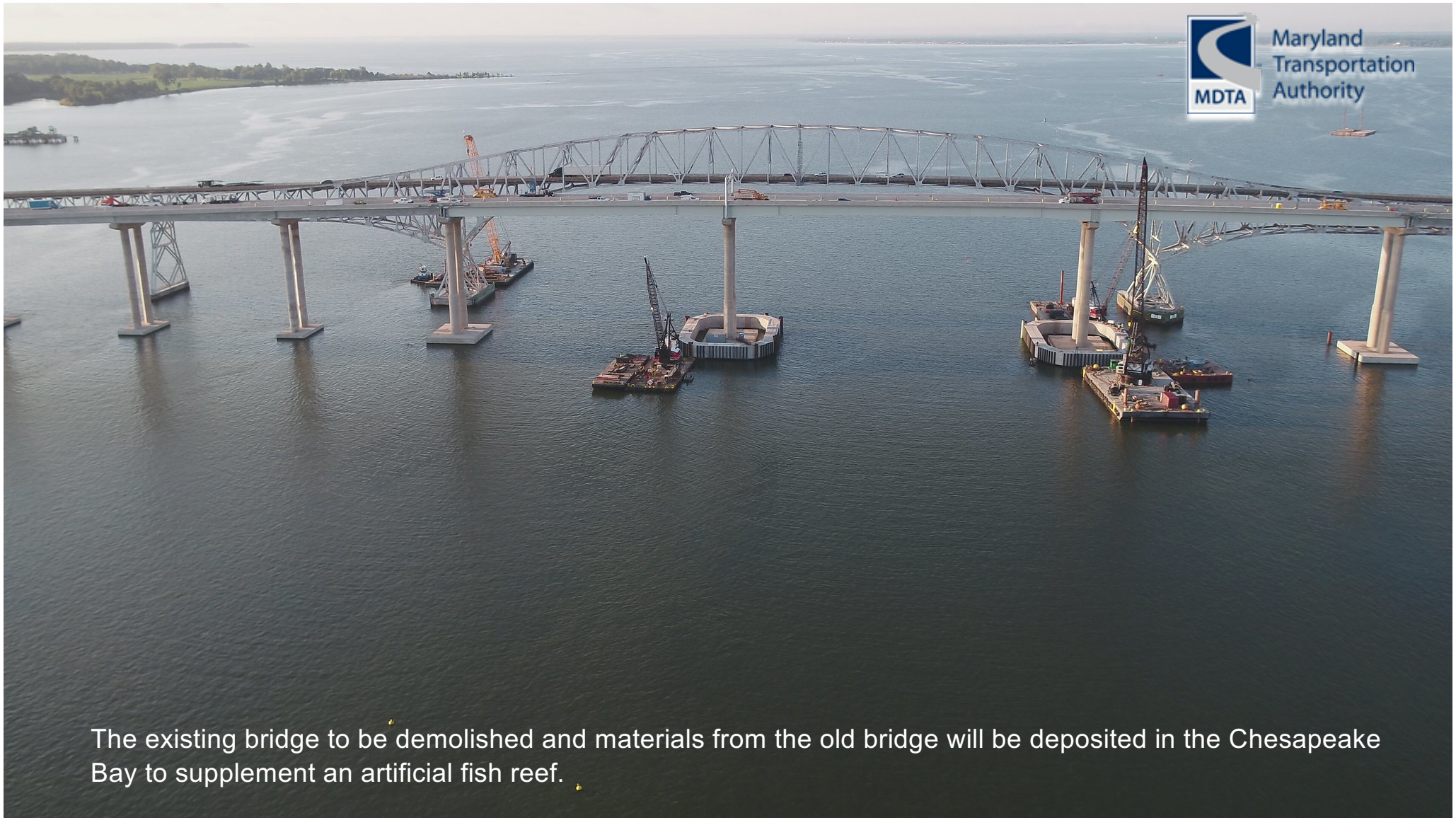
The new Nice Middleton Bridge

Maryland Transportation Authority
MDTA

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

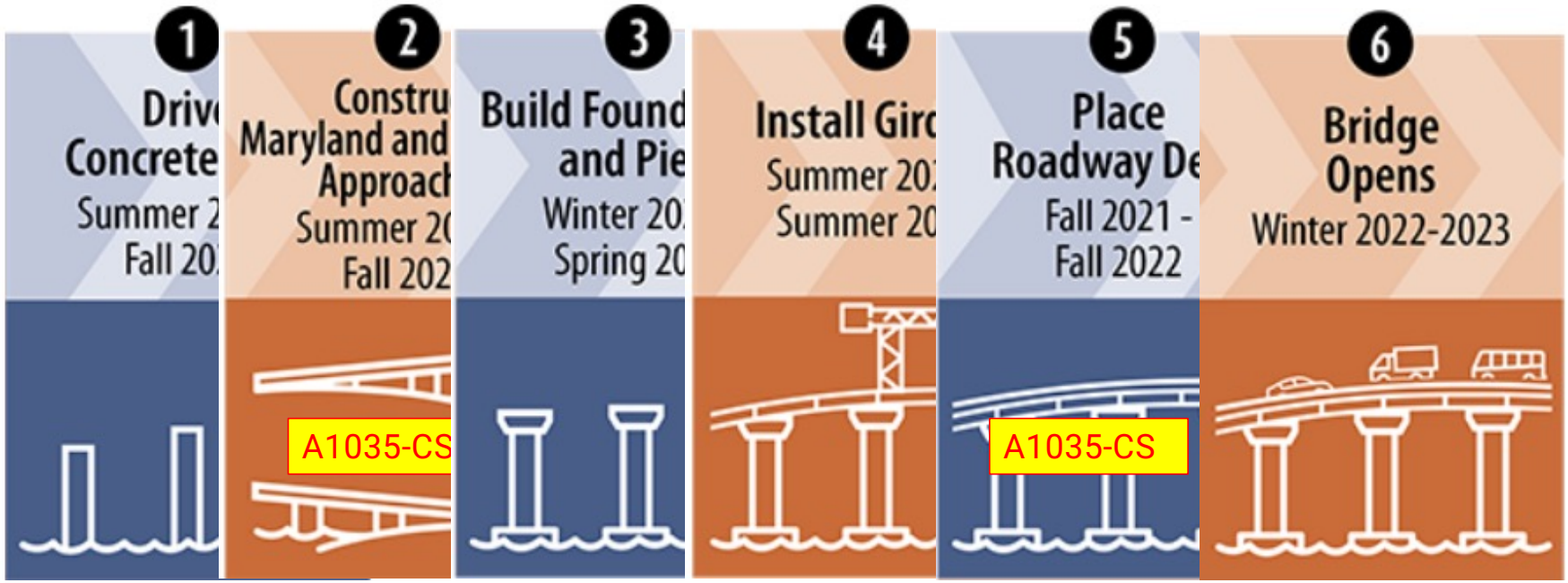
The largest project with A1035-CS in Maryland

- **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

Maryland Transportation Authority
MDTA

- 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

7.1.1.4.2 Reinforcement

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

3) Solid stainless-steel reinforcing bars conforming to AASHTO Designation: MP18M/MP 18-15. UNS* Designations S24000, S24100, S30400, S31603, S31653, S31803, S32101 and S32304.

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.

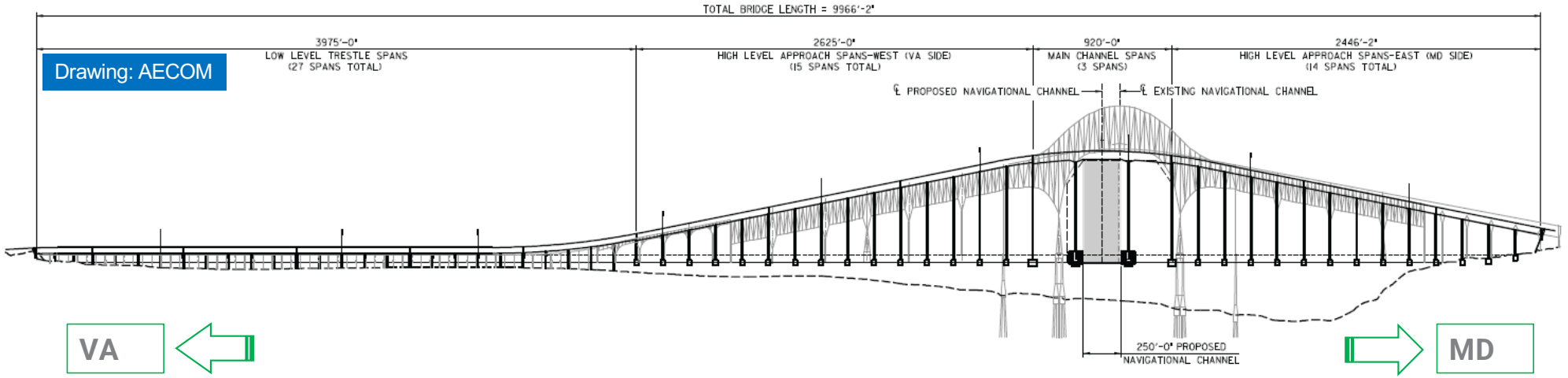
2) Parapets, rails, median barriers and terminal walls: All reinforcement including that which extends into the concrete deck slab, approach slab, retaining wall or moment slab.

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

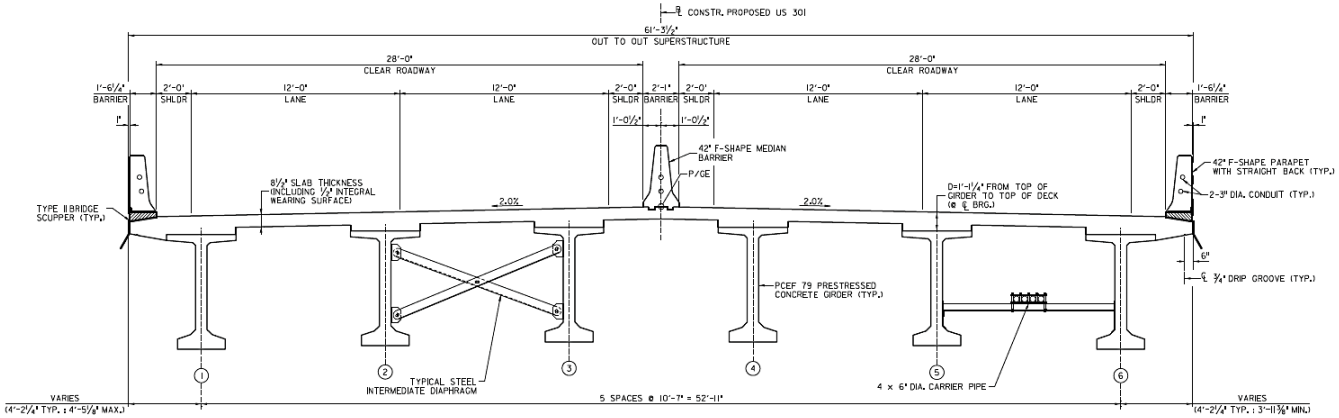
- 60,000 yard^3 of soil for embankments.
- Erosion and sedimentation control measures prior to construction
- Two temporary trestles built out onto the river. The MD trestle extends 240 feet from the shore into the river, while in Virginia it reaches 360 feet into the river.
- The A1035-CS rebar was used in the approach slabs (including sleeper slabs) and retaining walls.

May 2022 Maryland Approach looking West

August 2022 photo showing the Virginia side approach

Nice/Middleton Bridge Superstructure

Construction Sequence 5: prestressed concrete girders and CIP deck



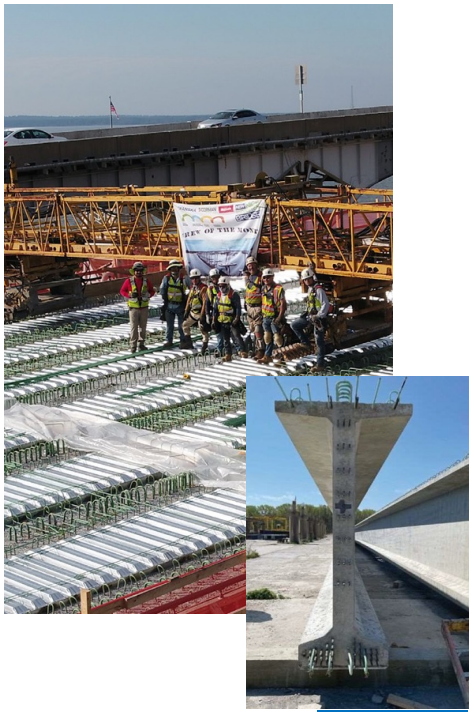


Photo: AECOM

- 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.

September 2022 photo High Level West from the Virginia side

Opening Ceremony

Nice/Middleton Bridge Project

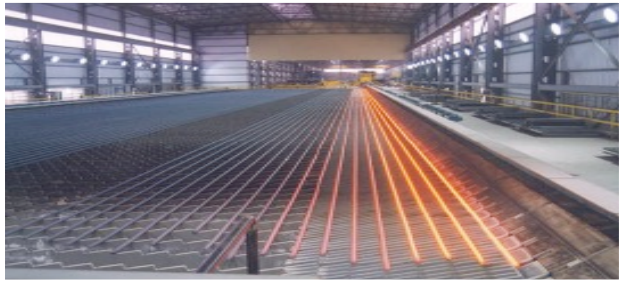
- On October 12, 2022 Maryland Delivers New Nice-Middleton Bridge on budget and three months ahead of schedule, replacing 82-year old span
- New Bridge doubles capacity, improves safety, and enhances emergency response activities
- CMC is extremely proud to be part of this landmark project.

A1035-CS Steel Facts

How is A1035 Made?

What Makes A1035-CS Different From Other Rebar?

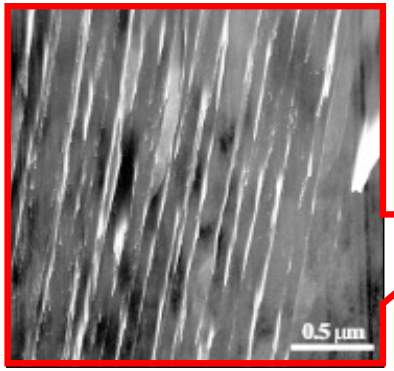
Controlled Melting Process



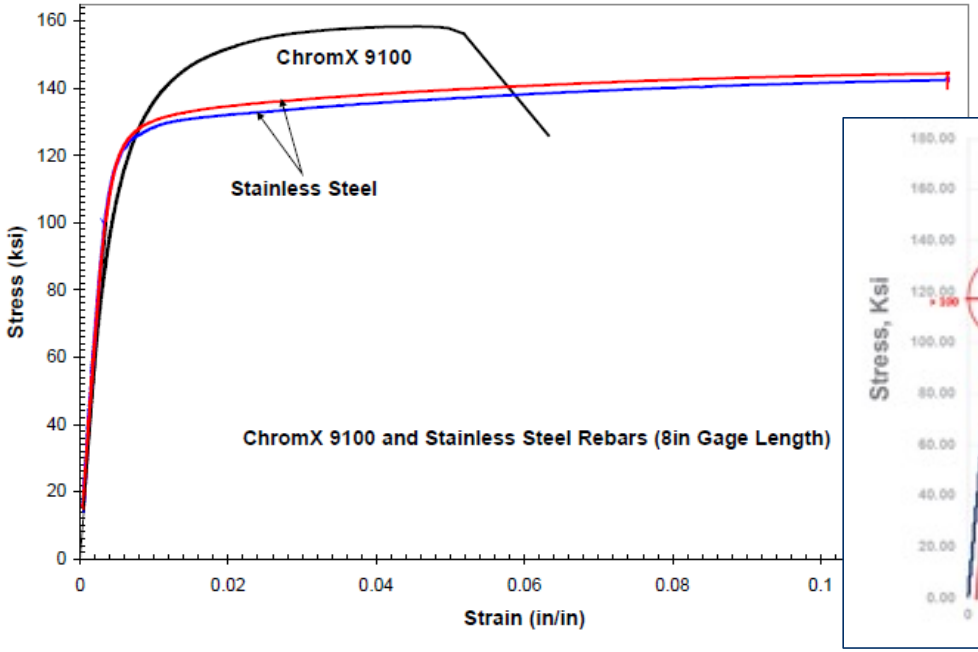
Controlled Rolling Process

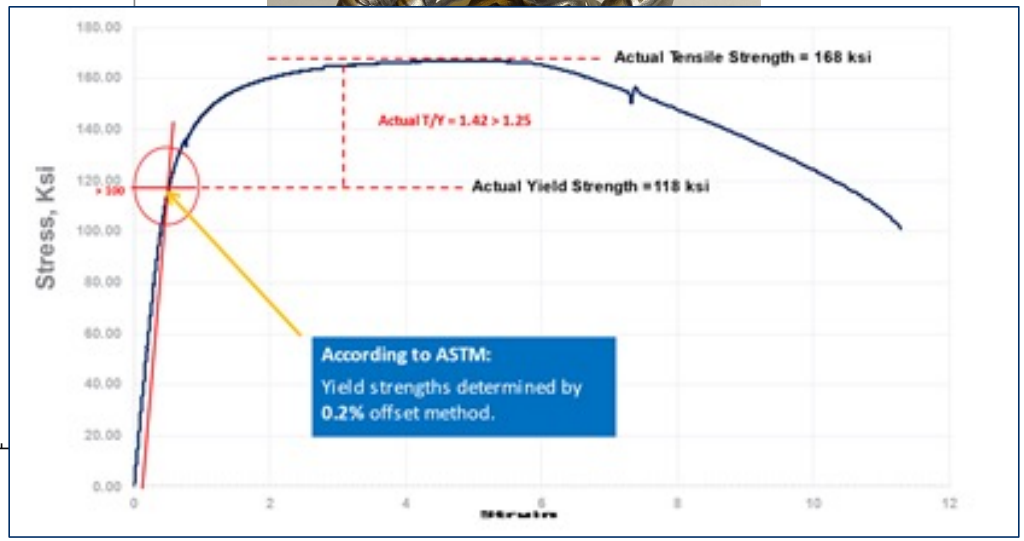
Martensitic - Austenitic microstructure provides:

- Corrosion Resistance
- High Strength with Ductility



ASTM A1035-CS vs ASTM A955





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

Tensile Requirements of ASTM A955 vs A1035

ASTM A955-20c vs ASTM A1035-20

ASTM A955

TABLE 3 Tensile Requirements[A]

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

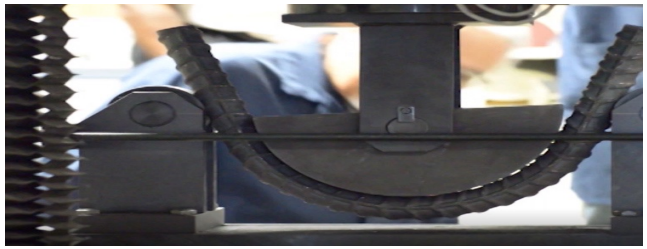
[A] Consult with the manufacturer for availability of grades and bar sizes.

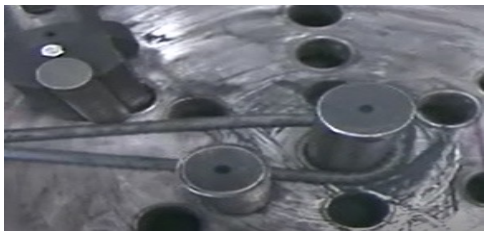
ChromX 9100ASTM A1035 CS

Tensile Requirements

Type	A1035 CS	
Grade	Grade 100 [690]	Grade 120 [830]
Tensile strength, min, psi [MPa]	150 000 [1030]	150 000 [1030]
Yield strength (0.2 % offset), mir [MPa]	100 000 [690]	120 000 [830]
Elongation in 8 in. [200 mm], mi		
Bar Designation No.		
3 through 11 [10 through 36]	7	7
14, 18, 20 [43, 57, 64]	6	6

T/Y ratio > 1.25





Steel fabricator: Commercial Metals Company, King George, VA

Deck reinforcement before concrete pour
Photo: CMC Fabrication King George, VA

Nice Middleton bridge deck
Photo: CMC Fabrication VA

The case for A1035-CS reinforcement

Corrosion plan developed by:

SIVA CORROSION SERVICES, INC.
Materials, Corrosion, and NDT Specialists

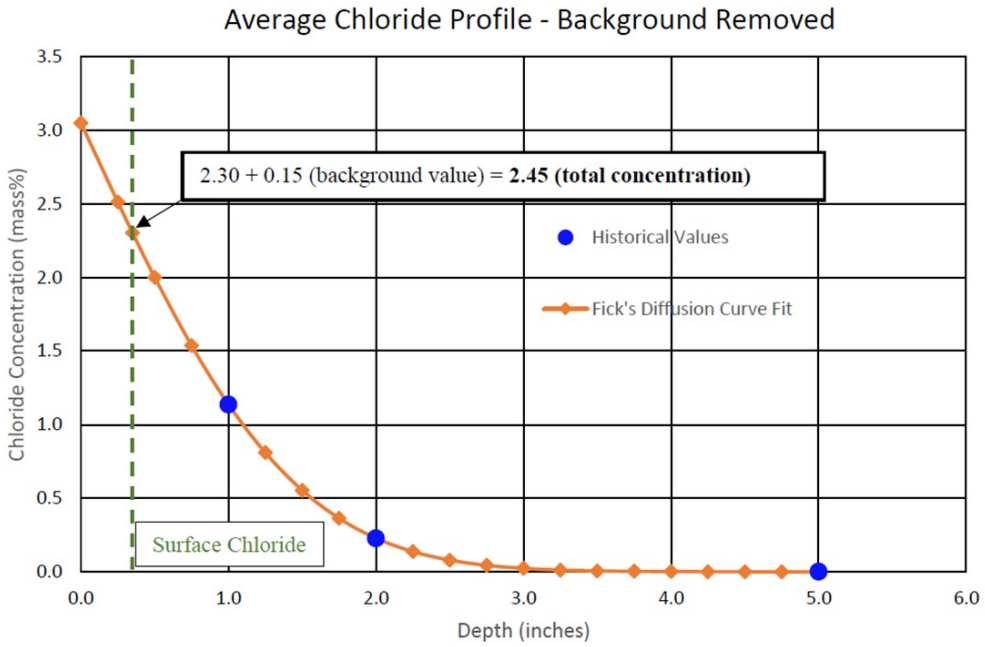
Fib 34 Service Life Model – Key Parameters

- 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

SIVA CORROSION SERVICES, INC.
Materials, Corrosion, and NDT Specialists

Selecting Appropriate Parameter Inputs

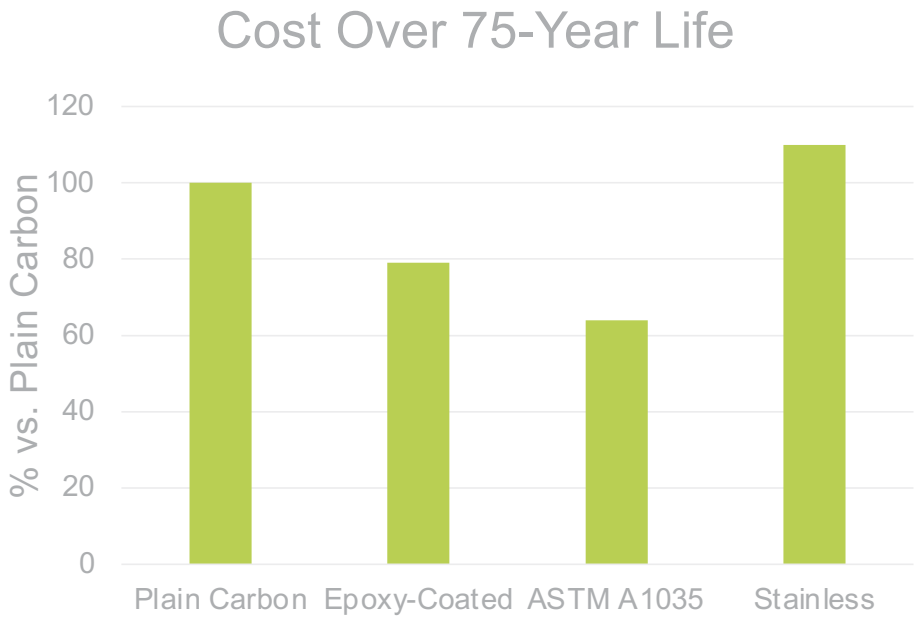
- Past Performance:
  - Measure chloride contamination at/near the new bridge site
  - Measure typical rebar concrete diffusion
  - Need statistical data
- Design Requirements:
  - Minimum cover
  - Cracking control



SIVA CORROSION SERVICES, INC.
Materials, Corrosion, and NDT Specialists

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.



SIVA CORROSION SERVICES, INC.
Materials, Corrosion, and NDT Specialists

ASTM A955 / A1035 Chemical Composition

TABLE 2 Chemical Composition[A]

UNS Designation[B]	Type[C]	Composition %									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Other Elements
						Austenitic Grades					
S24000	XM-29[D]	0.08	11.5–14.5	0.060	0.030	1.00	17.0–19.0	2.3–3.7	....	0.20–0.40	....
S24100	XM-28[D]	0.15	11.0–14.0	0.045	0.030	1.00	16.5–19.0	0.50–2.50	....	0.20–0.45	....
S31653	316LN	0.030	2.00	0.045	0.030	1.00	16.0–18.0	10.0–13.0	2.00–3.00	0.10–0.16	....
						Austenitic-Ferritic (Duplex) Grades					
S31803	2205[E]	0.030	2.00	0.030	0.020	1.00	21.0–23.0	4.5–6.5	2.5–3.5	0.08–0.20	....
S32101	....	0.040	4.0–6.0	0.040	0.030	1.00	21.0–22.0	1.35–1.70	0.10–0.80	0.20–0.25	Cu 0.10–0.80
S32205	2205[D]	0.030	2.00	0.030	0.020	1.00	22.0–23.0	4.5–6.5	3.0–3.5	0.14–0.20	....
S32304	2304[D]	0.030	2.50	0.040	0.030	1.00	21.5–24.5	3.0–5.5	0.05–0.60	0.05–0.20	Cu 0.05–0.60

[A] Maximum, unless otherwise indicated. Where ellipses (...) appear in this table, there is no requirement and the element need not be determined or reported.
[B] Unified Numbering System, UNS, is the designation for a metal or alloy described and established by Practice E527 and SAE J 1086.
[C] Unless otherwise indicated, a grade designation originally assigned by the American Iron and Steel Institute (AISI).
[D] Naming system developed and applied by ASTM.
[E] Common name, not a trademark, widely used in the concrete industry, not associated with any one manufacturer.

A955/A955M – 20c

TABLE 2 Chemical Compositions of Alloy Type

Alloy Type	Composition Max, %[A]						
	Carbon	Chromium	Manganese	Nitrogen	Phosphorus	Sulfer	Silicon
1035 CL	0.3	2.0–3.9	1.5	0.05	0.035	0.045	0.5
1035 CM	0.2	4.0–7.9	1.5	0.05	0.035	0.045	0.5
1035 CS	0.15	8.0–10.9	1.5	0.05	0.035	0.045	0.5

[A] Maximum unless range is indicated; percentages refer to weight [mass] percentages.

Price variability dependent on special alloys and volumes

CMC Performance Reinforcing Steel

A1035 Coiled Rebar *

Bar size #3* - #6
(10 mm – 19 mm)
Coil weight 4500 lbs/2 mt.

Straight Rebar

40', 60' standard
Custom lengths available
Bar size #3* - #18

The picture can't be displayed.

Smooth Rounds & Dowels

¾” to 2½” diameter
Dowel lengths 18”, 24” & 36”
Custom lengths upon inquiry
Available as A1035

CMC Performance Reinforcing Steel

Rebar Couplers

Different designs, types and sizes manufactured by:

Barsplice: www.barsplice.com

nVent: www.erico.com/lenton.asp

CMC/MMI: www.cmcmmi.com

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

nVent Lenton Coupler

A32K made of A1035 steel
100 ksi
Galvanized

Tru-Splice Coupler

A1035 steel
100 ksi
Galvanized

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

1. American Association of State Highway and Transportation Officials (AASHTO). 2017. *AASHTO LRFD Bridge Design Specifications,* 8th ed.
2. Virginia Department of Transportation (VDOT). 2020. *Manual of the Structure and Bridge Division: Part* 02.· *Design Aids and Typical Details.* Richmond, VA
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

CMC.COM