Cost Comparison of Corrosion Resistant Reinforcing Steel

Deployment Considerations

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Cost Comparison of Corrosion Resistant Reinforcing Steel

- Objective
  - Apply cost information in evaluating alternate reinforcing steel

Unit Prices for Rebar

(Materials-only, except as noted; early 12)

	Cost/lb (U.N.O.*)
Black (#4)	.48
Epoxy (#4)	.70
Epoxy II	.50
Galvanized	.68-.73
Purple ECR (includes fabric.)	1.18
Z-bar (includes fabric. & transport.)	1.25-1.50

MMFX-2 (stock length)	.94
Solid SS (#7) (w/surcharge)	2.02-2.95
Basalt FRP (10 mm) ($$/ft)*	0.64 (19.2 kip)
FRP ($$/sq ft)* (#5 and #6) ($$/lin ft)*	5 -6.60 1. -1.44

Cost of Deck Rebar (180’ x 80’ x 8 psf)

Black	**$55,296**	**Z-Bar**	**$144,000 - $172,800**
Epoxy	**$80,640**	**MMFX-2**	**$108,288**
Epoxy II	**$57,600**	**Solid SS**	**$232,704- $339,840**
Galvanized	**$78,336 - $84,096**	**Basalt FRP (8’/SF)**	**$73,728**
Purple	**$135,936**	**FRP (cost/SF)**	**$72,000 - $95,040**

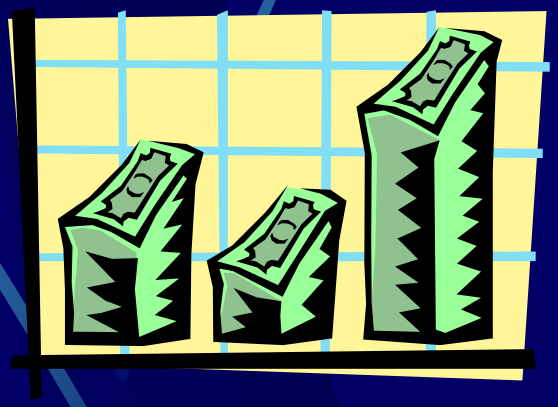
Thinking Beyond the Cost of Rebar…

- Cost impact to bridge project???
- Average bridge construction unit cost = $78/ft^2
- Cost of sample bridge = $1,123,200
- Using “normal” epoxy coated rebar as base level, building sample bridge using more corrosion resistant rebar will increase the initial construction cost ½% to 18%

Cost of Sample Bridge (180’ x 80’ x $78/sf= $1,123,200)

Black	**$1,178,496**	**Z-Bar**	**$1,267,200 - $1,296,000**
Epoxy	**$1,203,640**	**MMFX-2**	**$1,231,488**
Epoxy II	**$1,180,800**	**Solid SS**	**$1,355,904 - $1,463,040**
Galvanized	**$1,201,536 - $1,207,296**	**Basalt FRP**	**$1,196,928**
Purple	**$1,257,136**	**FRP**	**$1,195,200 - $1,218,240**

Real Costs: Beyond Initial Cost



- Life Cycle Cost
- Road User Delay Cost
  - Get in, Get out, Stay out!!!
  - Incentives to contractors
  - Public Perception

Review Quiz

You should only look at initial cost when reviewing reinforcing bar options. False

Using alternate reinforcing bars in the deck of a bridge will increase the initial cost of the bridge by over 50%. False

Each type of reinforcing bar material may be cost effective given the right situation. True

Deployment Considerations

- Objectives
  - Interpret the Buy America requirements
  - Understand proprietary product rules
  - Recognize technical implementation hurdles
  - Describe current practice and research

Buy America

23 CFR 635.410

- All foreign steel and iron material products are subject to Buy America Provisions regardless of the percentage they comprise in a manufactured product or the form they may take.

Buy America

- Manufacturing begins with the initial melting and mixing, and continues through the coating stage.
  - Chemical content
  - Physical size or shape
  - Final finish

Exceptions

- Alternate bids between domestic and foreign steel and iron products

- Minimal use of foreign materials
  - $\leq$ 0.1% of total contract cost or $2,500, whichever is greater

Waivers

- Public interest finding
- Materials not produced in the U.S. in sufficient and reasonably available quantities which are of satisfactory quality
- HQ approval required

"Buy America" Quiz

- Billets are produced in Italy and then shipped to U.S. for rolling and shaping.
  - ✕ Does not meet Buy America Provisions
- A steel beam is produced in U.S. and shipped to Canada for further fabrication (drilling of holes and welding).
  - ✕ Does not meet Buy America Provisions

Patented / Proprietary Products

(23 CFR 635.411)

- FHWA will not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications.

Exceptions

- Competitive bidding
- Essential for synchronization, or no equally suitable alternative exists
- Research or experimental purposes
- Public interest finding

Technical Hurdles

- Design
  - Utilization and optimization
- Corrosion performance
  - Accelerated laboratory testing
  - Actual field performance

Design – Utilization

- 2010 5th Edition AASHTO LRFD Specifications and Interim Editions
- ASTM 615 (uncoated and epoxy coated)
- ASTM A 706 (low-alloy steel / seismic design)
- ASTM A 955 (stainless steel)

Design – Issue to Resolve

- Yield Strength
  - AASHTO SS states designs shall not use a yield strength in excess of 60 ksi (8.3.3)
  - AASHTO LRFD states "…yield strengths in excess of 75 KSI shall not be used for design purposes." (5.4.3.1)

Design - Optimization

- Yield strength greater than 75 KSI
- Choosing reinforcement type based on design life and life cycle cost

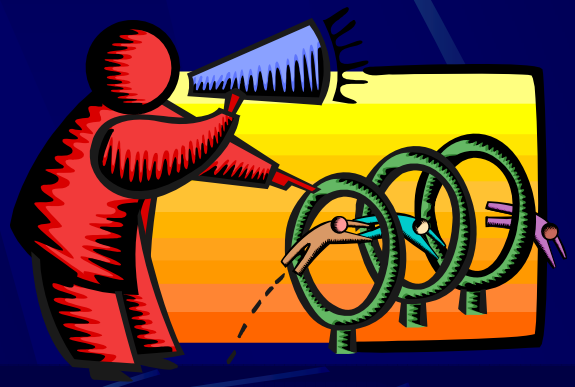
National Research

- FHWA/FLDOT – “Corrosion Resistant Alloys for Use as Reinforcement in Concrete”
- Investigate Solid Stainless, Stainless Steel-Clad and MMFX products
- Investigate corrosion resistance of project samples

Conclusions

If a steel product is not manufactured 100% in the U.S., it can not be used on a federal-aid project. False

You can not specify a proprietary product on a federal-aid project. False



Conclusions

(continued)

- Technical hurdles being overcome to implement corrosion resistant reinforcing bars:
  - Design
  - Results of laboratory tests
  - Lack of long-term experience with in-service performance

Conclusions
(continued)

- Current practice and research
  - Extra thick epoxy coated rebar
  - FRP rebar (basalt emerging)
  - Z-bar