Through the AASHTO RAC listserv, transportation agencies were asked if they had policies regarding use of corrosion resistant reinforcing.

**Virginia DOT** has adopted a Corrosion Resistant Reinforcing Steel Policy. The policy discontinues the use of epoxy coated and galvanized bars. In order to achieve a 75 year bridge life corrosion resistant reinforcing steels are used as follows:

1. ASTM A1035 (low carbon, chromium) – MMFX2
2. Stainless steel conforming to ASTM A955 – UNS designations: S24100, S30400, S31603, S31653, S32101, S32201, S32205
3. Stainless steel clad bars conforming to AASHTO MP13M. Note: At this time the clad bars are not produced in the U.S. and do not meet “Buy America”.

**Oklahoma DOT** does not have a policy and has used MMFX on an experimental basis.

**Maryland State Highway Administration** does not have a written policy but has used stainless steel rebar. Their latest special provision allows the substitution of stainless for epoxy coated rebar. Stainless steel meets the requirements of ASTM A955 – UNS designations: S31803 or S31653.

**Delaware DOT** does not have a written policy. They have used MMFX on two projects and stainless steel clad on one project and used fy = 60 ksi for design in all cases.

**Alaska DOT** does not have a policy.

**Mississippi DOT** - Mississippi does not use much de-icing salt and does not have bridge deck corrosion problems like other states. We do not have a written policy on the use of corrosion resistant reinforcing steel. If a Contractor requested a substitution of a corrosion resistant steel, we would consider that on a case by case basis. We would not allow the Contractor to reduce the amount of reinforcing steel required by the original design just because their proposed substitution reinforcing steel had a higher yield strength.

The **Wyoming Department of Transportation** has not specified MMFX reinforcing steel. Their specifications allow the contractor the option of providing green epoxy coated or galvanized reinforcing steel.

**PennDOT** primarily uses epoxy coated reinforcement for corrosion protection of its steel reinforcement in structures. It is used in various locations throughout the structure. They also allow for the use of galvanized steel in place of epoxy steel at a 1:1 replacement. Stainless steel is permitted in the top and bottom mats of deck reinforcement as part of their dual deck protection initiative (with FHWA and Chief Bridge Engineer approval). PennDOT prefers and are strong proponents of using the dual protection system on higher volume bridges. FHWA has the final say on where and when used. Stainless steel reinforcement bars are in accordance with ASTM A 955/ A 955M, Grade 420 (Grade 60) meeting one of the following UNS Designations: S24100, S30400, S31653, or S31803.
Oregon DOT specifies stainless steel in the bridge deck for coastal areas, defined as one air mile from the ocean, and marine environments, defined as any location with salt water. A high performance concrete (HPC) and minimum 2” clear cover for cast in place concrete is required. For snow and ice areas epoxy coated steel with 2.5” top rebar clear cover and 1.5” bottom rebar clear cover with HPC is specified. Waterproofing membranes are used when other alternatives such as epoxy coated rebar, stainless steel, increased concrete cover and HPC cannot be used. Stainless steel meets requirements of UNS – S31653, S31803, or S20910. Grades 60 and 75 are specified (minimum yield of 60 ksi and 75 ksi).

Iowa DOT does not have a written policy on the use of CRR. Their practice (bridges and structures) can be summarized in the following bullets:

- CRR other than epoxy coated rebar is generally limited to experimental projects. We have used MMFX steel, galvanized steel, stainless steel clad, and may be a few others for research purposes.
- We specify epoxy coated steel in all bridge decks, railing, walls, and substructure elements that are exposed to salt spray.
- We use stainless steel rebar for connecting stub abutments to bridge approaches. We are looking at other applications for stainless steel.
- Otherwise, black steel is specified.

Indiana DOT does not have provisions for CRR.

Kentucky Transportation Cabinet does not have a policy. They have used on experimental basis: stainless steel clad, MMFX, glass FRP and carbon FRP.

New York DOT Bridge Manual includes comprehensive guidance on the use of CRR. This is given the current NYS DOT Bridge Manual, Section 15.12. The Bridge Manual is available online at: https://www.nysdot.gov/divisions/engineering/structures/manuals

The following is a summary:

- The designer has three choices available for protecting reinforcement: corrosion inhibitors, coating the reinforcement (epoxy, galvanized) and corrosion resistant metal (stainless). The decision of which protection(s) to specify is dependent on a variety of factors including location within a structural element, cost, durability, ease of placement, expected service life, and importance of the structure.
- Solid stainless steel and stainless steel clad reinforcement are appropriate when the added durability reduces cost, either long-term or during construction. This can occur when environmental conditions are particularly severe, when the cost of repairs is unusually high, due to heavy traffic or construction conditions, when design of concrete sections as uncracked under service load is not feasible and when cover is less than standard.
• Solid Stainless and stainless steel clad require approval of the Chief Engineer on a case by case basis.

*Florida DOT* hasn’t implemented a permanent change to their specification allowing the use of SS rebar. Notice that they would not use MMFX. Even 304 would not be used at this point as the amount of Molybdenum is not large enough and data is still being gathered on the performance of the rebar.

They allow 316 or better (2205 for instance).

The end caps on clad bar would be crucial as it is a weak point for that kind of rebar. I would definitely not allow plastic caps as the possibility of crevice corrosion would be large, however, the jury is still out on the extend of the corrosion.

The latest special provision allows stainless steel clad or solid stainless ASTM A955 UNS – S31603 or S31803, Grade 60.

*Arizona DOT* specifies epoxy coated rebar for locations above 4000 ft elevation and other areas that use de-icing chemicals. Also stated, in the bridge design guidelines, that the use of MMFX or stainless steel reinforcing must be approved by both the Bridge and Materials Groups and that it must be discussed in the Bridge Selection Report.

*Washington DOT* uses epoxy coated rebar at specified bridge locations for corrosion protection and does not have policy or use other CRR.

*Minnesota DOT’s* policy regarding the use of epoxy coated steel is as follows; “All reinforcement bars except those that are entirely embedded in footings shall be epoxy coated.” They have also recently developed a draft policy on the use of stainless steel reinforcing.

**DRAFT – NOT FINAL**

11/23/09

**Policy on the use of Stainless Steel Reinforcement in Bridges:**
Recent studies have shown that stainless steel reinforcement used in bridge decks is approximately 10-20% more cost effective on a life-cycle basis than epoxy coated reinforcement. This research also indicates that a bridge deck built with stainless steel reinforcement will likely last up to 100 years, while a deck built with epoxy coated reinforcement is expected to last between 50-60 years. A recent review of several major Minnesota bridge projects indicates that adding stainless steel deck reinforcement adds approximately 2-4% to the total bridge cost. The use of stainless steel deck reinforcing is also consistent with practice in Canada and Europe.

*(Hastings 2.8%, Lafayette Steel 3.8%, Lafayette Concrete 3.4%)*

While this added cost is certainly not insignificant, it should be noted that typical costs for a deck replacement are about 40% of the cost of a complete bridge replacement. Also, on some bridge types, including concrete box girders, it is not possible to replace the deck without supporting or shoring the superstructure from below, which is generally not possible on large river crossings or other bridges that
require large clear spans. Deck replacement on very high volume traffic routes is also very problematic as the bridge deck generally can’t be replaced one lane at a time, so significant traffic volumes need to be detoured or temporarily rerouted, which again is very difficult on major river crossings and other major structures that have limited width or right-of-way. These constructability, performance and cost characteristics make stainless steel bridge deck reinforcement an excellent alternative for such structures.

Hence, for bridges with unique superstructure types such as concrete box girders, and for all bridges with a construction cost exceeding $25 million (2009 dollars), unless an alternative system is approved by the Bridge Design Engineer, the bridge deck and concrete barriers shall be designed using stainless steel reinforcement or other similar high performance deck reinforcing that provides a design life of 100 years.

Stainless steel or high performance bridge deck and concrete barrier reinforcement should also be considered for bridges with an estimated construction cost under $25 million (2009 dollars) if site specific conditions such as detour length, traffic volumes, or other unique features result in significant undesirable consequences if the bridge deck lasts less than 75 years.

Bridge decks constructed using stainless steel reinforcement are not required to include a 2 inch low slump concrete wearing course, but top reinforcing bars in the deck shall have at least 3 inches of concrete cover, 4 inches for concrete box girder bridges. The yield stress used for design purposes for stainless steel and other specialized reinforcement shall not exceed 75 ksi.

Concrete box girders or similar structure types should also be detailed to incorporate stainless steel reinforcing in areas with a high potential for cracking or chloride exposure, such as transverse superstructure closure joints, expansion joints and, if utilized, anchorage areas adjacent to the top deck of cast-in-place superstructure construction. For these locations all the bars within the top deck, including those bars that cross into the top deck, will utilize stainless steel bar. Additionally, use stainless steel bars for all anchorage areas of cast-in-place spans.

To prevent potential corrosion issues related to the use of dissimilar metals, designers should limit the integration of galvanized or bare metals (such as galvanized conduits, or bare metal forming hardware) with stainless steel reinforcement. To avoid this potential issue, consideration should be given to isolating bare metal hardware or galvanized conduits from stainless steel reinforcement using non-conductive spacers.

1Comparison of Cost Effectiveness of Stainless Steel-Clad and Other Corrosion-Resistant Reinforcing Bars in Bridge Decks; J. Lawler, P. Krause, WJE Associates, Inc, 08/1/08
2Does Stainless Cost Less? Assessing the Feasibility of Stainless Steel as a Reinforcement Material for Bridge Decks on the Basis of Life-Cycle Costing; A. Cope, S. Labi, Purdue University School of Civil Engineering, TRB 2009

From MnDOT’s latest draft spec, “The Contractor shall supply test results from an independent testing agency certifying that the materials conform to Grade 75 deformed reinforcement bars per ASTM A 955, including the annex, and must conform to one of the following UNS designations; S24100, S32205, S32304, S20910, S30400, S31603, S31653, S32201, or S31803.”

**Missouri DOT** does not have a policy.

**Nevada DOT** does not have a policy.

**Connecticut DOT** has no policy on the use corrosion resistant reinforcement (CRR) such as MMFX or stainless steel. Current policy requires the use epoxy coated reinforcement in specific structural components, such as decks, deck parapets, median barriers,
prestressed superstructure members, and approach slabs. In a few structures, they have used galvanized reinforcement instead of epoxy coated reinforcement. The CTDOT has begun researching the use of CRR but has not developed a policy for its use.

West Virginia DOT does not have any specifications that pertain to stainless steel clad or other alloys of corrosion resistance such as manufactured by MMFX. Our specifications currently only indicate epoxy coated bars for corrosion resistance. A few years back we had a research project that involved stainless clad epoxy bars, but this was a research test and therefore no specifications beyond the project plans was adopted.