Stainless Steel Coated Rebar for Chloride-Resistant Concrete Highway and Bridges

Samuel McAlpine, PhD
Allium Engineering, Inc.

Rebar Corrosion in Infrastructure

Reinforcing steel (rebar) is a key component of concrete highway bridges. The corrosion of rebar embedded in concrete leads to volumetric expansion as the metallic iron is converted into iron oxide. This volume expansion causes degradation and eventually spalling of the surrounding concrete.This is the major lifetime-limiting factor for highway bridges across the US, and is a major driver of repair and maintenance costs for VTrans. This corrosion is driven by deicing salts applied during the winter months.

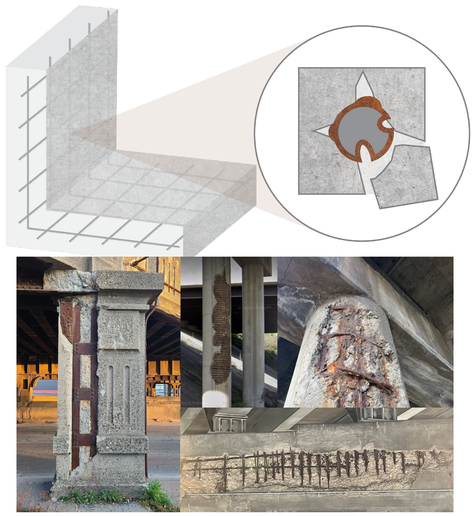

Figure 1. (Top) Schematic diagram showing rebar corrosion degradation of concrete. (Bottom) Spalled concrete on bridges.

Innovative Manufacturing for Stainless-Clad Rebar

Allium Engineering, Inc. has developed an innovative material and manufacturing method to overcome this rebar corrosion problem in a cost-effective manner while preserving the beneficial mechanical properties of steel. By coating the outer surface of the rebar with stainless steel, the lifetime of a concrete bridge can be extended significantly without increasing the cost to the same extent as pure stainless steel rebar. Allium has developed an innovative laser deposition technology which applies the stainless steel onto the semi-finished steel billet before hot rolling into finished rebar material.

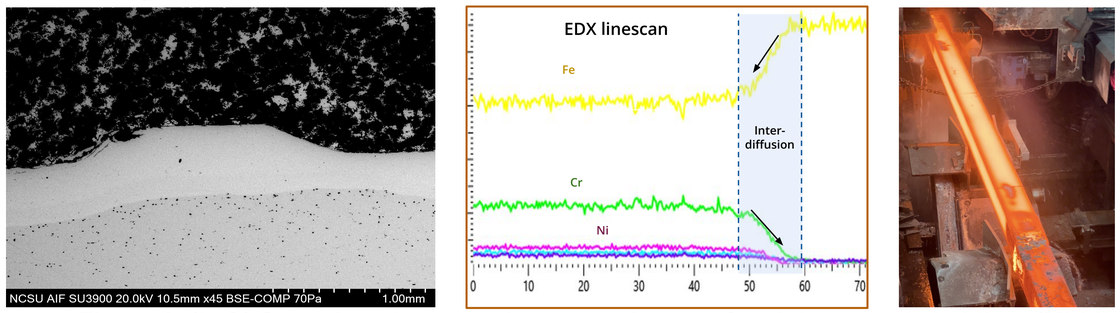

Figure 2. (Left) Scanning electron microscope image of stainless steel cladding. (Middle) Composition linescan demonstrating the interfacial region with interdiffusion and metallurgical bonding. (Right) Clad billet during initial stages of the hot rolling process.

Macrocell Corrosion and Tensile Mechanical Testing

In order to assess the corrosion performance of stainless-clad rebar, macrocell testing was conducted in the same manner used for pure stainless steel rebar per ASTM A955. This test demonstrated a 13X reduction in corrosion rate compared to conventional black rebar. Mechanical tensile testing was also performed which demonstrated that the yield strength and ductility are unchanged.

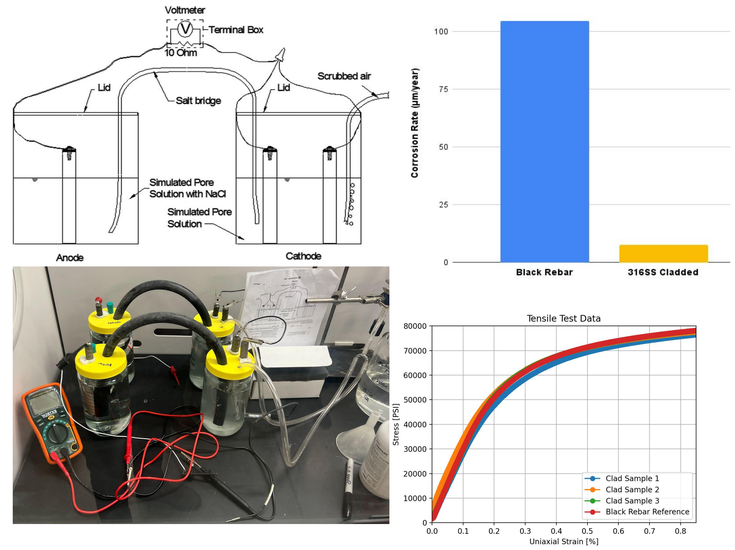

Figure 3. (Top Left) Schematic diagram of the macrocell corrosion test, adapted from ASTM A955. (Bottom Left) Picture of macrocell test setup in the lab. (Top Right) Macrocell corrosion test results. (Bottom Right) Tensile test results showing mechanical properties of rebar.

Conclusions

Upon completion of this project, the focus has shifted towards manufacturing scale up and initial project applications. Allium has established an initial manufacturing plant in Billerica, MA capable of producing 3 tons/day of stainless-clad rebar. Initial pilot projects with VTrans are planned for the Lowell and Springfield bridge projects.

Acknowledgments

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References

[1] McAlpine, Samuel. *Stainless Steel Coated Rebar for Chloride Resistant Concrete Highway and Bridges*. No. NCHRP IDEA Project 240. 2023