Zinc-Rich Coatings Over High Strength Steel

NSRP SPC Panel Meeting

September 2023

Concept Description

- Zn-rich coatings are often avoided on high strength steels due to long held concerns of hydrogen embrittlement, particularly in heat affected zones
- Recent research suggests hydrogen embrittlement may not be an issue with Zn primers, potentially allowing for the use of more effective corrosion barriers throughout ship construction
- The team will work with Navy technical advisors to develop requirements and conduct testing to demonstrate the effects of Zn-rich coatings under environmental and hot work conditions in order to pursue future approval for use on Navy ships

Previous Work

- Zinc-rich Coatings for Enhanced performance of Polysiloxane Topside Coatings, 2013
  - Research was done previously demonstrating the benefits of Zn-rich coatings with polysiloxane topcoats on Navy vessels. The study showed that the performance of such a system was beneficial overall but did not examine the possible issue of high strength steel substrate degradation from a zinc coating
- Sacrificial Coatings for the Corrosion Protection of Armor Steel, 2013
  - Research showed zinc-rich paint on armor steel offers substantial corrosion benefits. Minimal concern for EAC on non-loaded high hard armor steel
- NNS Hydrogen Diffusivity into High Yield Steel as Zn Corrosion Product Study
  - High Strength Steel coated with Inorganic Zinc Silicate and a control coating (Navy Formula 84, Rev. C)
  - Samples tested periodically over 1104 days of environmental exposure in Newport News, VA
  - Pseudo-slow strain rate tensile tests with fractography
  - No Obvious Property Degradation from Inorganic Zinc on high strength steels evaluated

Anticipated Benefits

- Zn-rich coatings provide additional corrosion protection during downtime and prevent excessive remediation efforts

- Inorganic Zn-rich coating have a higher thermal stability compared to organic coatings.
  - Reduction in coating removal

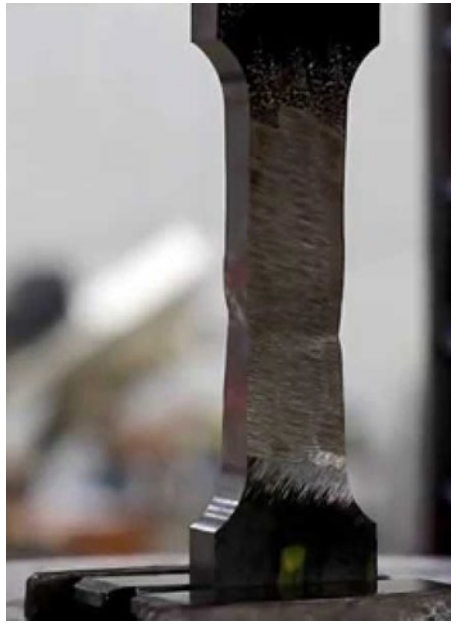
- Additional labor savings in not having to restore a steel surface to a near white metal finish.

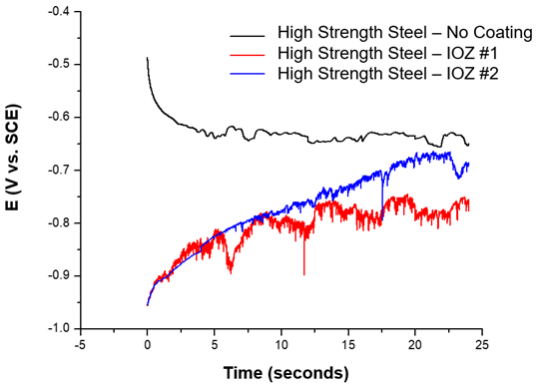
Scope of Work

- This project will evaluate the effect that Zn-rich coatings have on high strength steel.
- Goals/Objectives
  - Establish a credible testing protocol to assess base metal, heat-affected zone (HAZ), and deposit filler metal susceptibility to reduced properties associated with Zn-rich coatings
  - Generate data to understand the relative impact of Zn-rich on high strength steel
  - Depending on testing results, provide list of alternative coating systems and appropriate areas of application
  - Provide recommendations for shipyard and Navy consideration

Tasks

- Identify Target Applications, Requirements, and Constraints
  - Hold Kick-off Meeting with project team to discuss high value target applications, identify coating types for consideration, discuss performance testing strategies.
- Select Candidate Systems, Finalize Test Requirements, and Test Plan
  - Team will work with Navy technical advisors to develop test plan.
- Fabrication of Test Articles and Laboratory Testing
  - Test articles will have the appropriate Zn-rich coatings applied in a fashion consistent with shipbuilding operations with a focus on potential worst-case situations.
- Final Report





Kick Off Meeting Highlights

- Testing to include
  - F519 Bars (Army and USMC requirements)
  - Weighted Wedge Break Test (HY100 Current requirement)
  - Slow Strain Rate (known testing for fatigue)
  - Compact Tension (CT) Samples (NRL work presented at DoD Corrosion)
- Alloys of interest
  - 4340 (known Hydrogen embrittlement susceptibility)
  - HY-100
  - HSLA-100 comp 3
- Coatings of interest
  - PCPs, IOZ coating, OZ, Non Zn-rich

Path Forward

- Select Candidate Systems, Finalize Test Requirements, and Test Plan
  - Team will work with Navy technical advisors to develop test plan
    - Finalize test plan by 10.30.2023
  - Begin testing November 2023 through Spring 2024
  - Depending on testing results, provide list of alternative coating systems and appropriate areas of application

Questions?

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