College of Engineering
Department of Mechanical & Industrial Engineering

College of Engineering
School of Electrical Engineering & Computer Science

To Predict ▶ To Design ▶ To Perform

ME, ECE Capstone Design Programs

Team #03: Corrosion Mitigation and Quantification

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Background

- Lower sections of structural steel beams are experiencing accelerated corrosion rates due to petroleum coke and moisture.
- Factors that can affect the corrosion rate are metal properties, chemical attack, and atmospheric conditions.

Objective Statement

Research and develop cost effective solutions for mitigating corrosion. Test and validate the solutions to have one installed on site.

Engineering Specification

Corrosion Rate Allowance	<5 mils/year	✓
pH of The Corrosive Material	6-8	✓
The Height of Coke Buildup	0”-36”	✓
Temperature of Substrate	Amb-≈100°F	✓
Relative Humidity	60-90+%	✓
I-Beam Dimension	W8x31	✓

Safety Consideration

- Coating SDS
- Installation vendor with good safety record
- Appropriate lab and site PPE
- Mechanical properties of metallurgical upgrade

Test Samples

Epoxy Coatings

Metallurgical Upgrade/Metallic Coatings

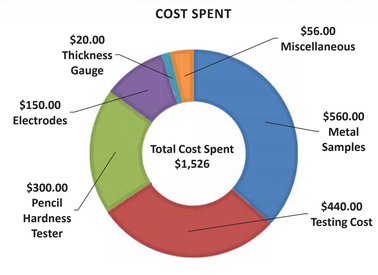
Fabrication

Carbon Steel welded to Galvanized Steel

Carbon Steel welded to 304L Stainless Steel

CAD Model and final assembly for stress corrosion cracking test for welded samples

Budget ($20,000)



Estimated Cost for Installation: $7,800
Budget Available: $10,674

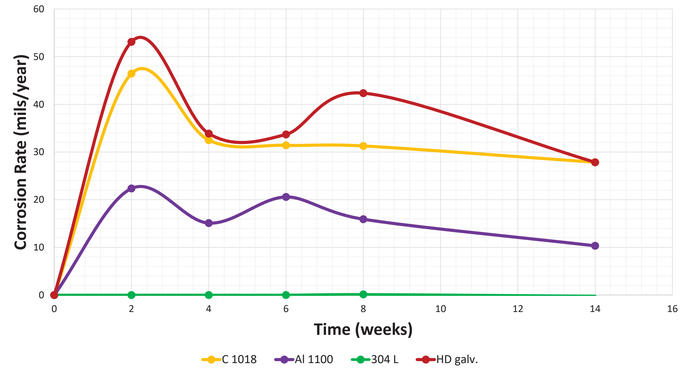
Testing & Analysis

Field Testing

Objective: To obtain corrosion rate on metal/welded samples and measure performance of coated samples

1. Install each sample in field
2. Measure weight loss, hardness, and thickness over time
3. Observe microstructure

Corrosion Rate vs. Time

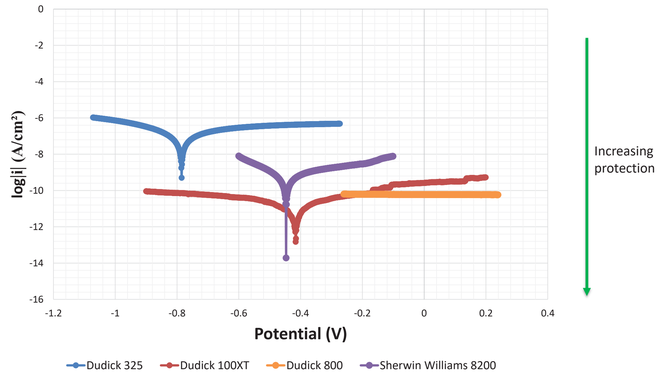


Laboratory Testing

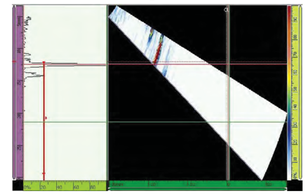
Objective: To obtain coating ranking in terms of effectiveness using a potentiostat and accelerated testing by heat cycles

Corrosion Rate (mils/year):
Dudick 800: 0
Dudick 100XT: $1.72x10^{-5}$
Sherwin Williams 8200: $4.32x10^{-4}$
Dudick 325: $5.47x10^{-2}$

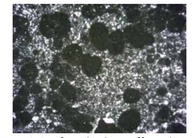
Coating Results



Monitoring Stainless Steel Weld Cracking using NDT



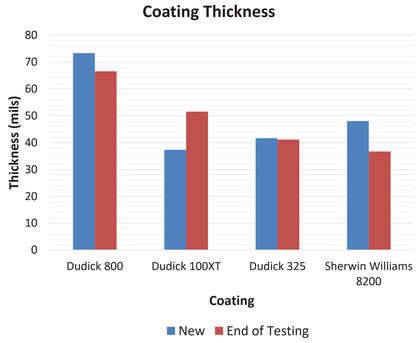
Phased Array Ultrasonic Testing for internal cracks on weld



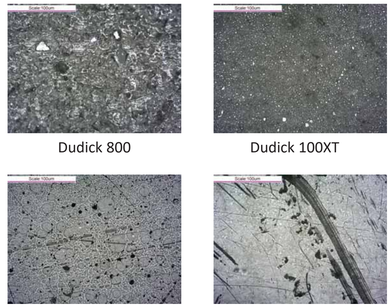
Significant pitting found in heat affected zone of weld

- Number of internal cracks found = 7
- Final corrosion rate of 304L/A36 welded specimen from weight loss = 9.4 mils/year

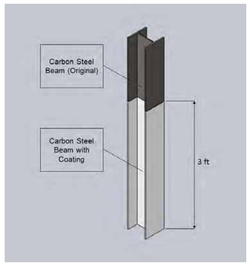
Thickness Readings of Coated Coupons

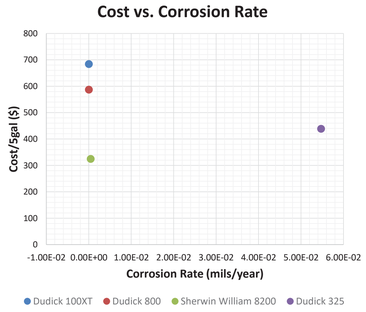


Microstructure of Coated Coupons



Solution(s)





September	October	November	December	January	February	March	April	May
Research Problem Concept Generation	Concept Evaluation & Selection	Drawings & Designs Engineering Analysis	Test Planning Quoting Test Material	Fabrication and Beginning of Testing	Fabrication & Testing	Testing & Analysis	Testing, Analysis, & Evaluation	Final Report & Installation

Sponsors: Paul Koenig (Oxbow Calcining)

Advisers: Dr. Sunggook Park