Iowa State University Bridge Research Overview and Updates

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Overview

- Highlights of ongoing or recently completed bridge research projects

- Evaluation of galvanized and painted-galvanized piles at Buffalo Creek Bridge – Buchanan County, IA

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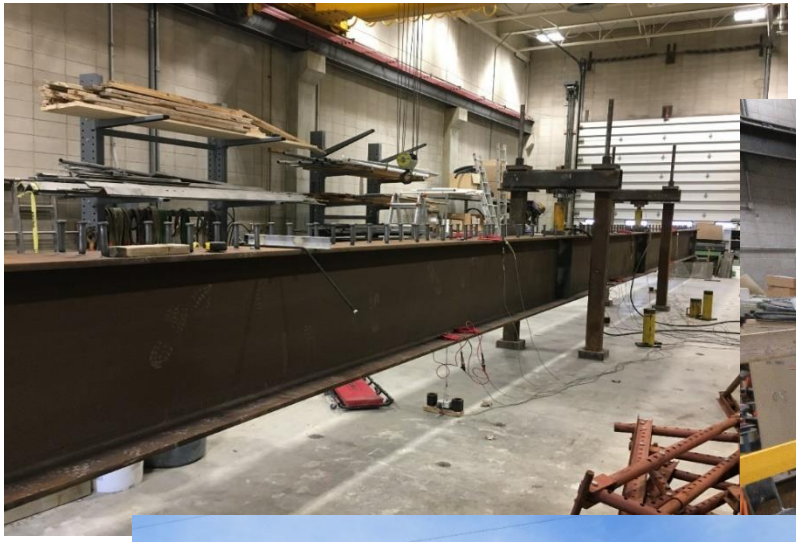
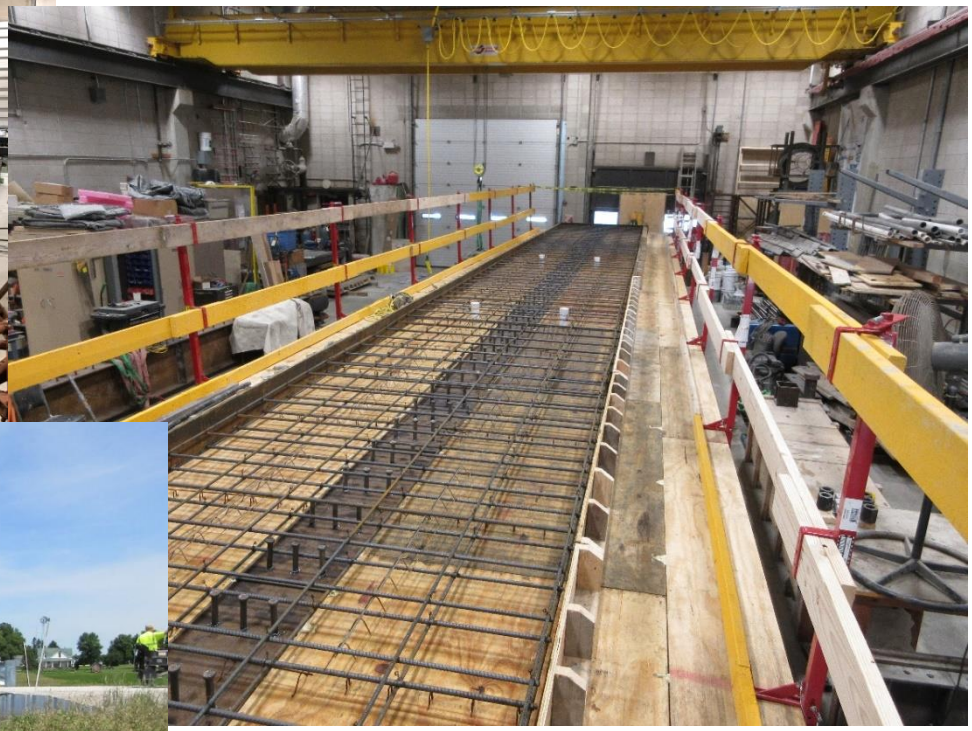
Evaluation of A709 Grade QST Steel





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Assessment, Repair, and Replacement of Bridges Subject to Fire

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Impact of Legalized 25-kip Axle Loads for Self-Propelled Implements of Husbandry

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Helical Pile Foundation Implementation for Bridge Structures

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Lab Evaluation of Cross-Laminated Timber Decks

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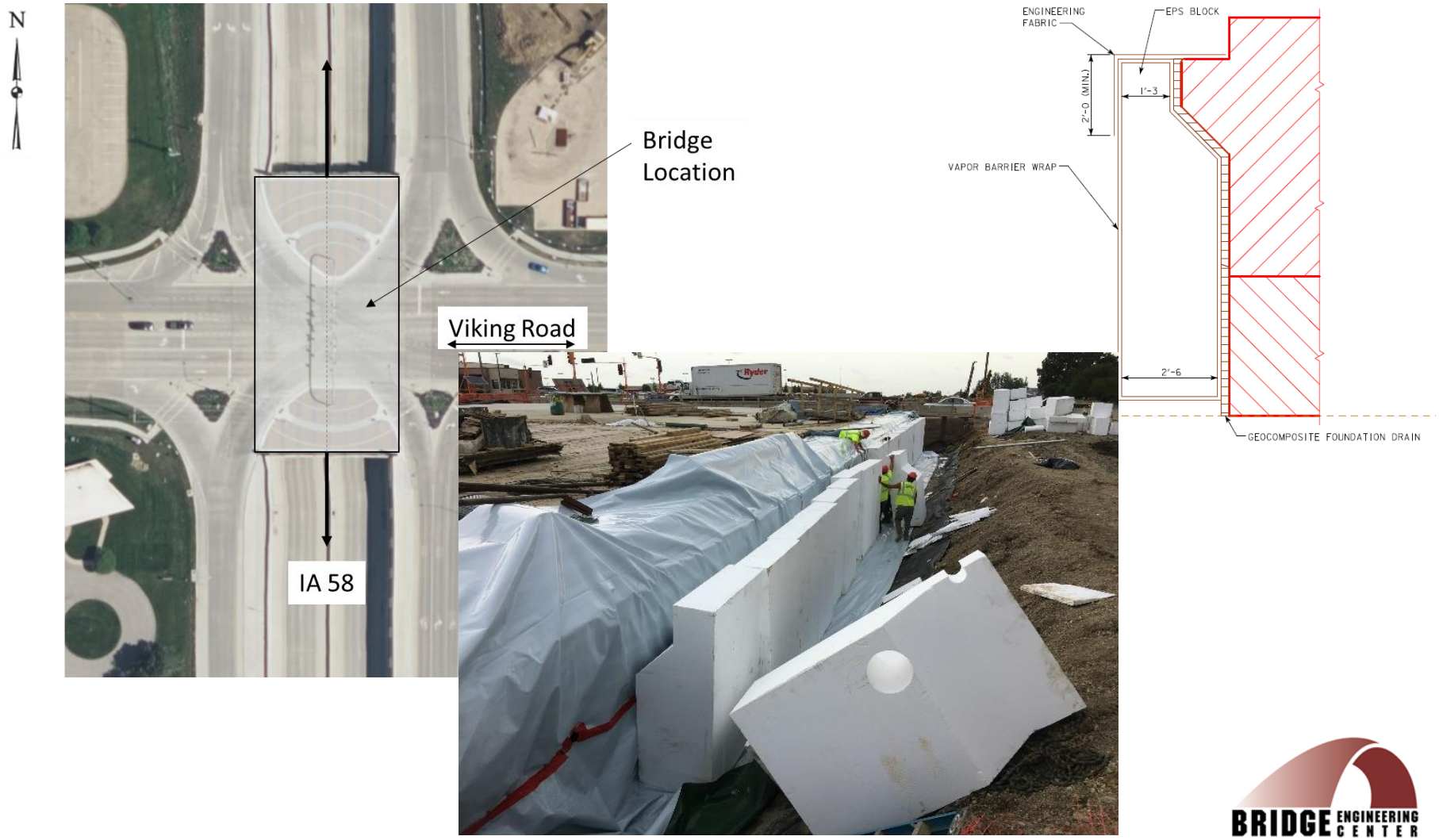
Implementation of Recommendations for Eliminating Longitudinal Median Joints in Wide Bridges



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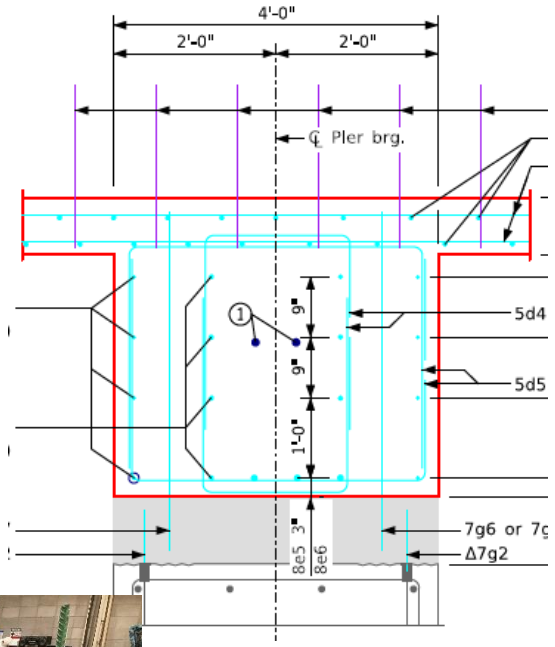
Multi-Span Lateral Slide Connection Evaluation



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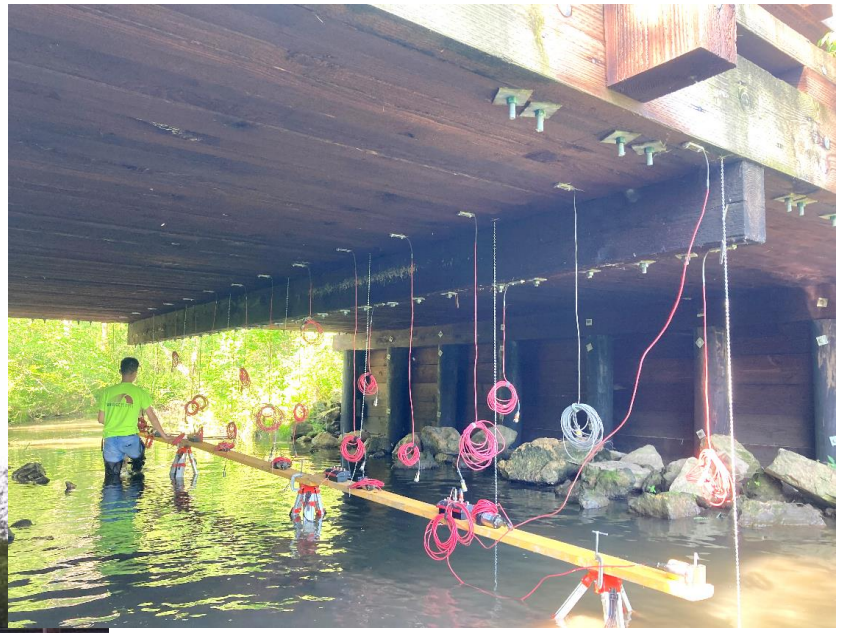
Analytical and Testing Methods for Rating Longitudinal Laminated Timber Slab Bridges



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Evaluation of Galvanized and Painted-Galvanized Steel Piling

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Background

- Concrete encased piles are common for Iowa DOT and Iowa County structures
- Encasements can become expensive and increase construction time
- Exposed piles can be alternative if service life can be increased/predicted
- Cases of early deterioration and pile corrosion have resulted in interest in using coatings to protect piles

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Objectives

- Evaluate the effectiveness of galvanized and painted-galvanized piles at extending bridge service life
- Evaluate the economic viability of using coating systems

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Scope

- Cyclic corrosion testing (CCT)
- Periodic bridge site evaluations
- Economic comparisons

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CCT – Specimen Types

- Bare steel
- Galvanized steel
- Galvanized-painted
- Galvanized-painted damaged
- Galvanized damaged

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Steel Specimens

Sample Type	Uncoated (S)	Galvanized (G)	Galvanized and Painted (P)	Damaged (D)
2”x2” Coupon	3	3	3	3
1 ft Pile	3	2	2	2

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Painted Specimens

- Carboguard 893 – Primer
  - Cycloaliphatic Amine Epoxy
- Carbothane 133 LH – Top Coat
  - Aliphatic Acrylic-Polyester Polyurethane

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Cyclic Corrosion Testing

- 24 hr cycles for 600 days
- 100 year equivalent
- Multiple samples of uncoated, galvanized, galvanized-painted piles

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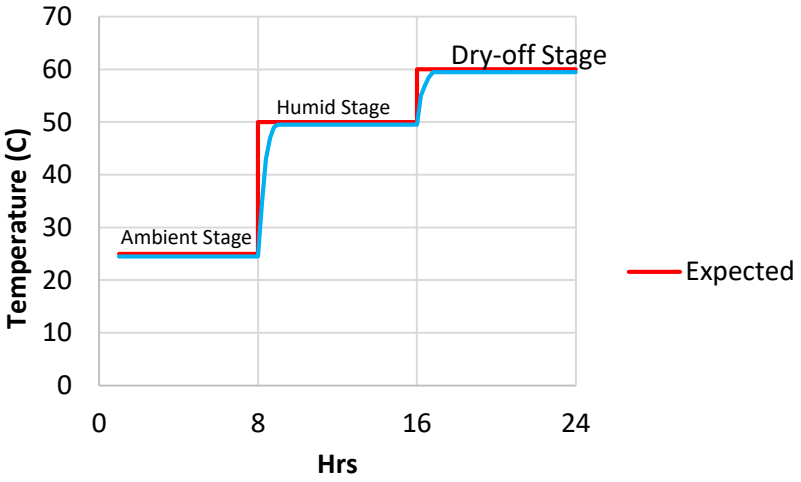
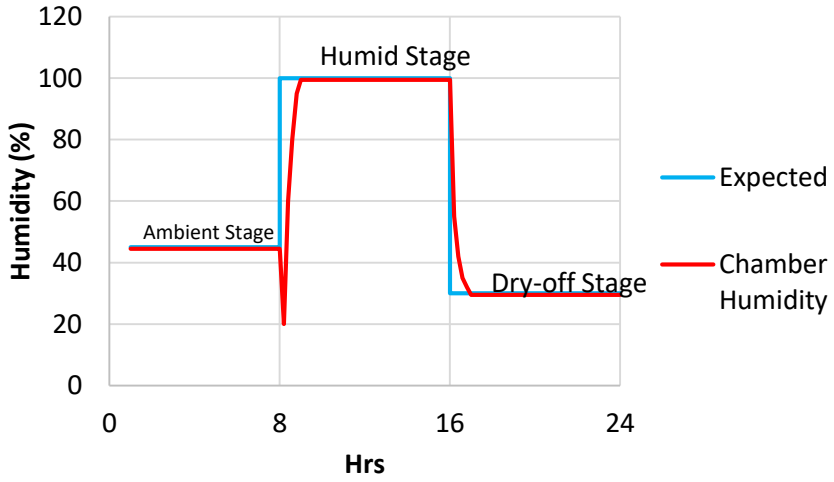
Cyclic Corrosion Testing

Continuously subject to the humidity and temperature cycles for 600 days





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Bare Steel - No Protection

Day 0

After 600 days

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1 ft pile samples

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Galvanized

Day 0

After 600 days

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1 ft pile samples

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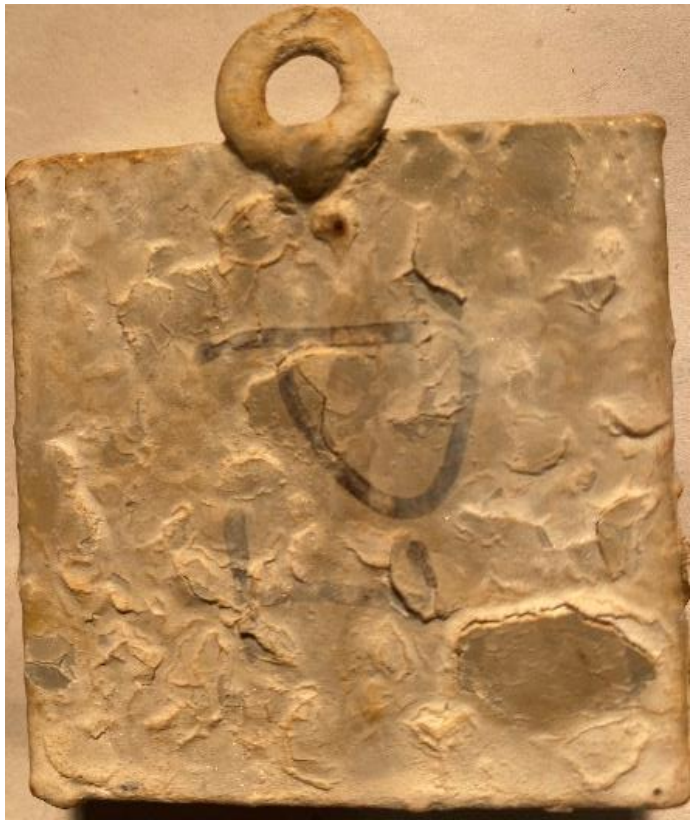
Galvanized and Painted

Day 0



After 600 days

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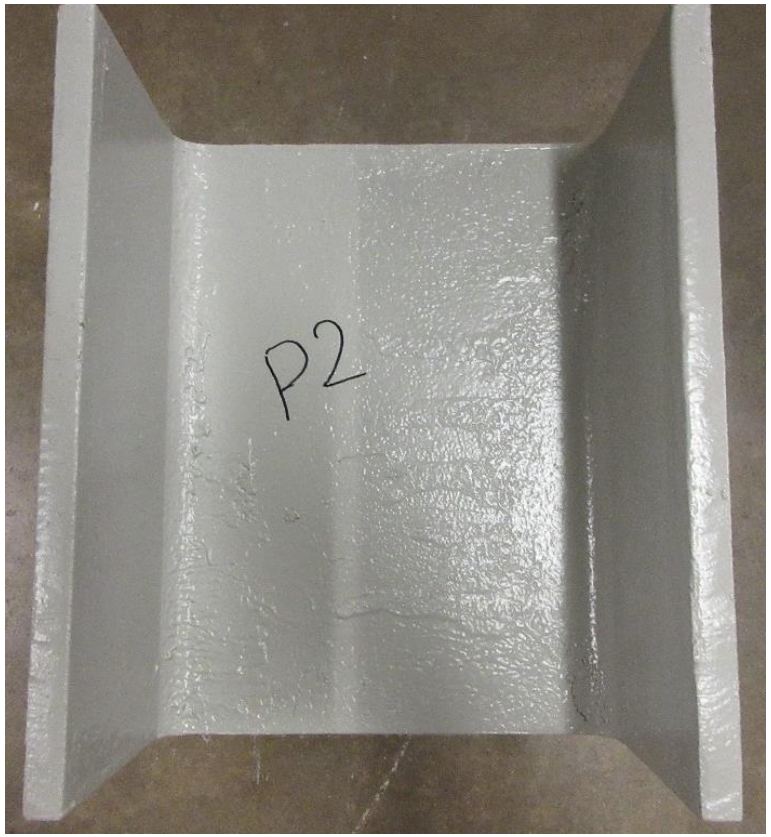
1 ft pile samples



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Damaged galvanized-painted

Day 0

After 600 days

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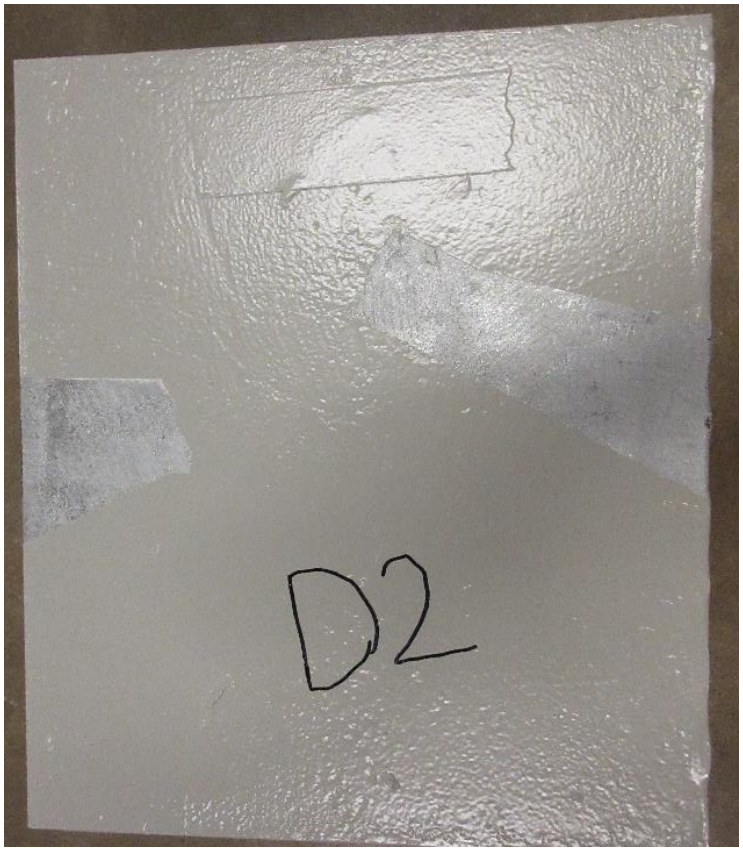
1 ft pile samples



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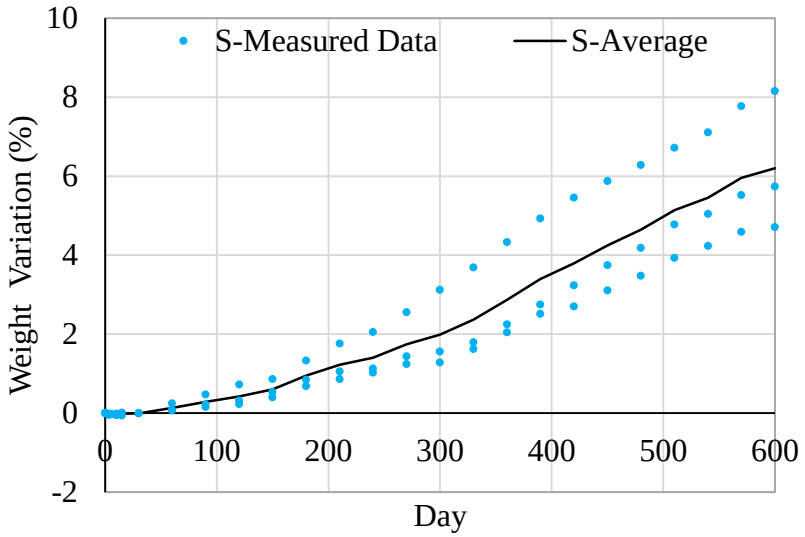
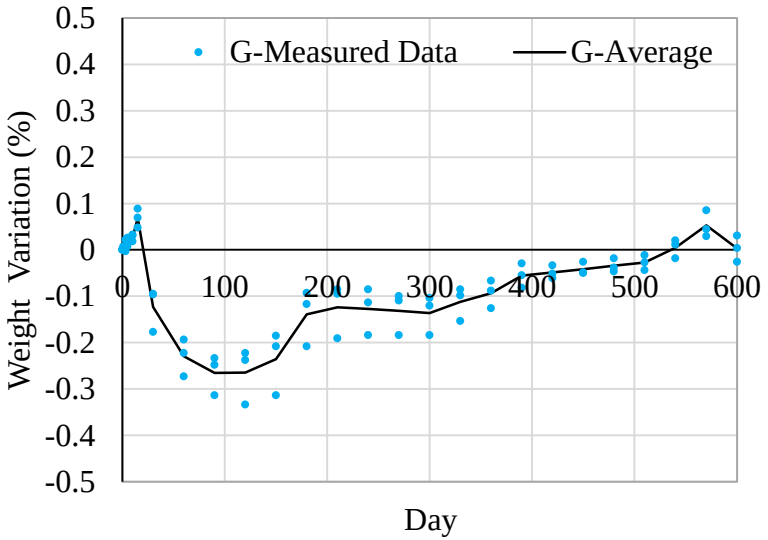
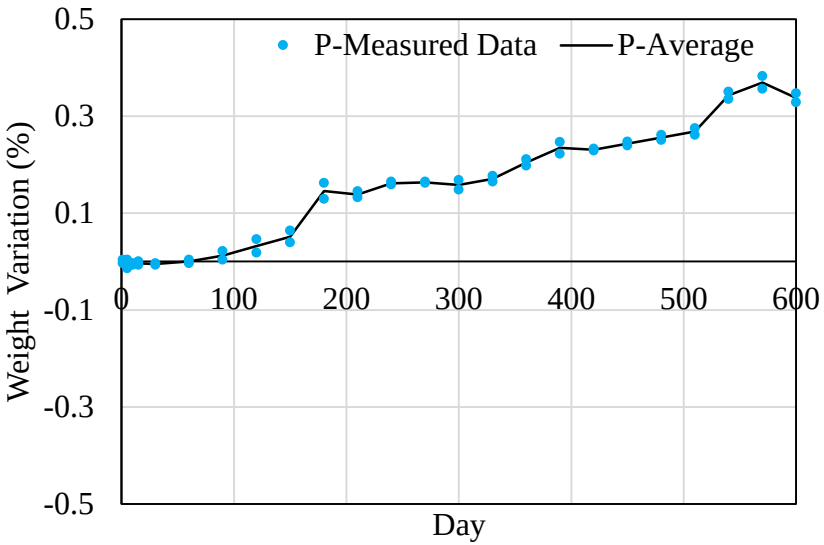
No Coating

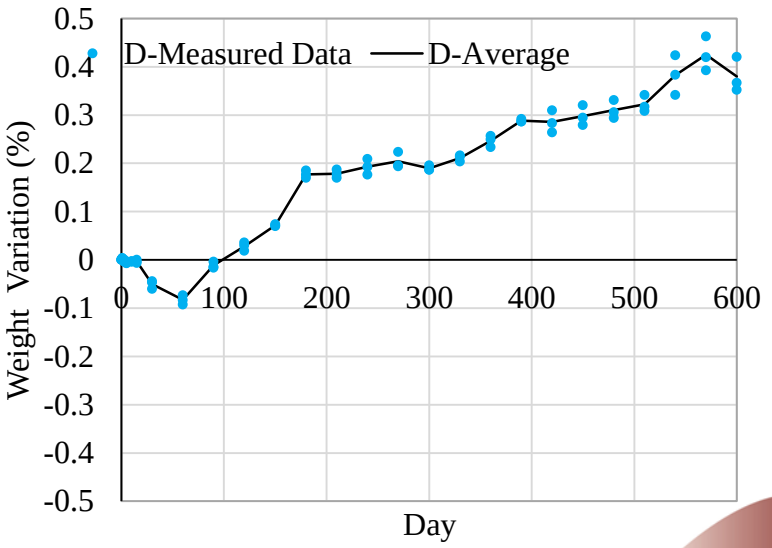


Galvanized





Painted



Damaged

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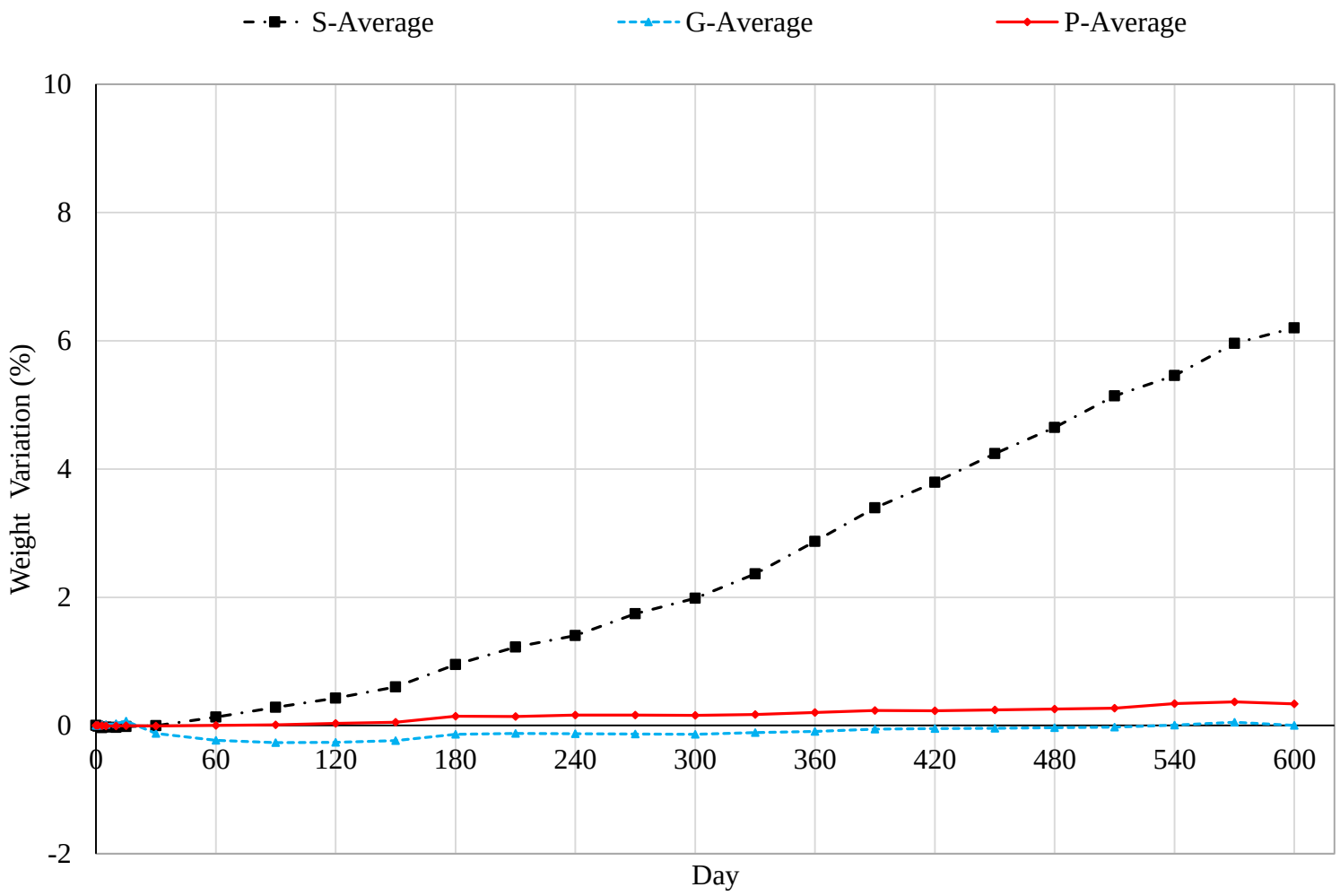

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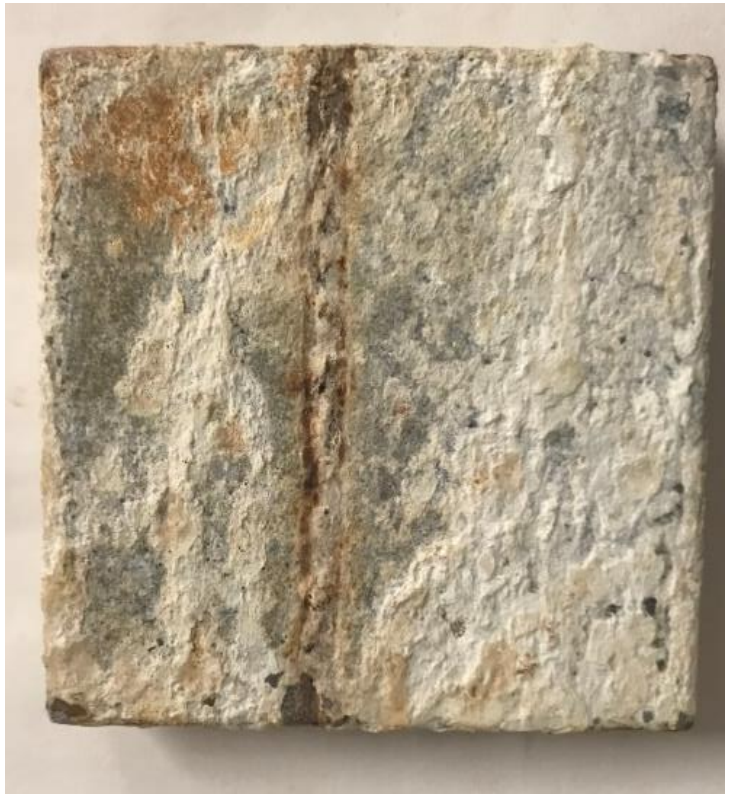
SG-18 :

Scratched Galvanized with scratch width of 1/8”

After 7 days



After 600 days

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SG-28 :

Scratched Galvanized with scratch width of 2/8”

After 7 days

After 600 days

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SG-38 :

Scratched Galvanized with scratch width of 3/8”

After 7 days

After 600 days

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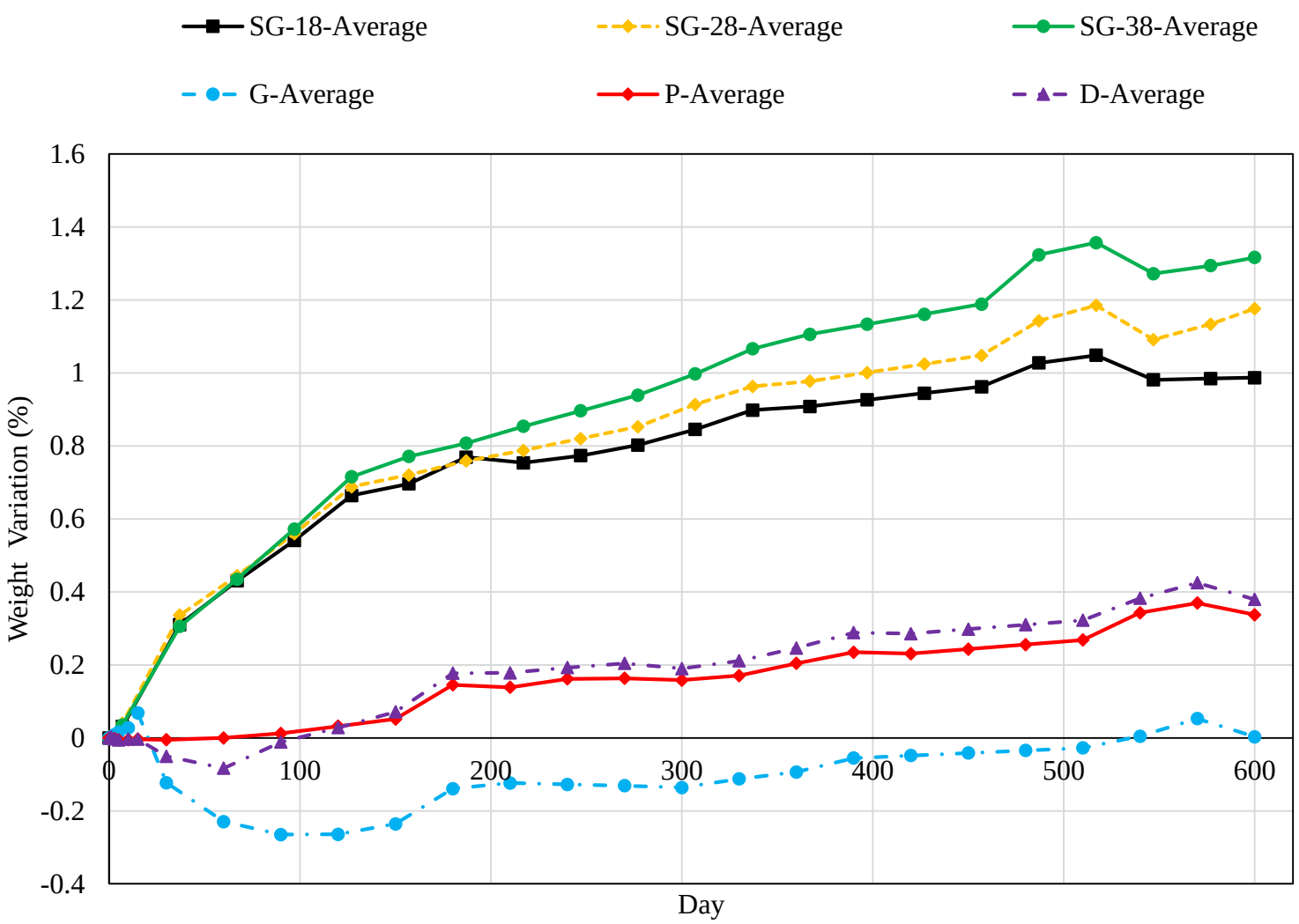

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Field Investigation

- Buffalo Creek
- Fall of 2018
- HP10x57 piling galvanized and painted

- Thickness measurements of steel piling flanges collected at regular intervals

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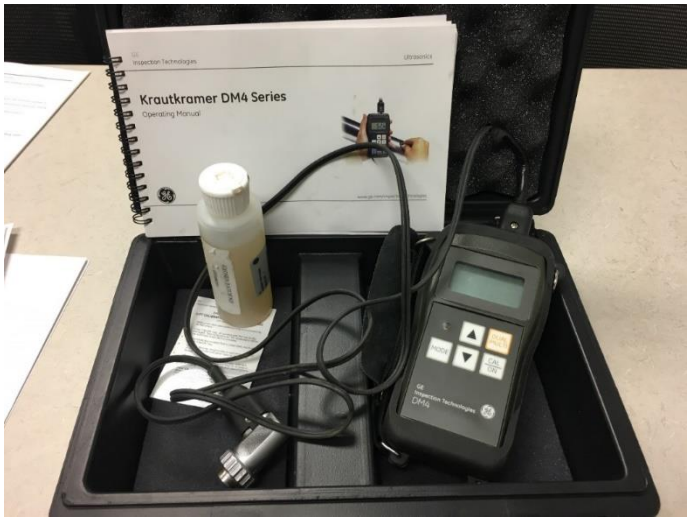
Ultrasonic Testing



10 flange locations near ground/water/ air interface

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Observations

- Galvanized layer is effective for providing protection of steel
- Paint coating offers additional protection initially but eventual degradation of paint leaves galvanized layer as single protection measure
- Damaged paint without damaged galvanized layer performs similarly
- Damaged galvanized layer offers better protection to smaller scratches (self-healing)

Cost Comparison

- Option #1 = Increase pile size to provide sacrificial material
- Option #2 = Galvanize original pile size
- Option #3 = Galvanize and paint original pile size

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Assumptions

Buffalo Creek Bridge Project 2019
HP 10x57, 10x90’ @ each pier, 8x80’ @ each abutment

- Bare steel piles = $36/ft installed
- Galvanized and painted = $85/ft installed
- Galvanized (60% of cost increase) = $65/ft installed

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Bare steel service life

- Increase pile size to achieve same service life
- Conservatively assume installed cost is proportional to weight increase

HP 12x74 = 1.30 x HP10x57 = $46.80/ft

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Cost Comparison

	HP 10×57 Bare steel	HP 10×57 Galvanized	HP 10×57 Painted-galvanized	HP 12×74 Bare steel
Cost ($/LF)	$36	$65	$85	$47
Cost over the cost of HP 10×57 Bare steel	100%	182%	236%	130%

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Recommendations

- Continue to pursue galvanize coatings on piles to protect bare steel and extend service life
- Include painted coatings to further extend service life or if in especially corrosive soil types
- Consider increase in pile size to provide sacrificial material if cost to galvanize remains comparably high

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QUESTIONS

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