Effectiveness of FRP in Reducing Corrosion in a Marine Environment

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2009 US Army Corrosion Summit
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Pile Corrosion

Courtesy - Alltrista

Pile Corrosion

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Outline

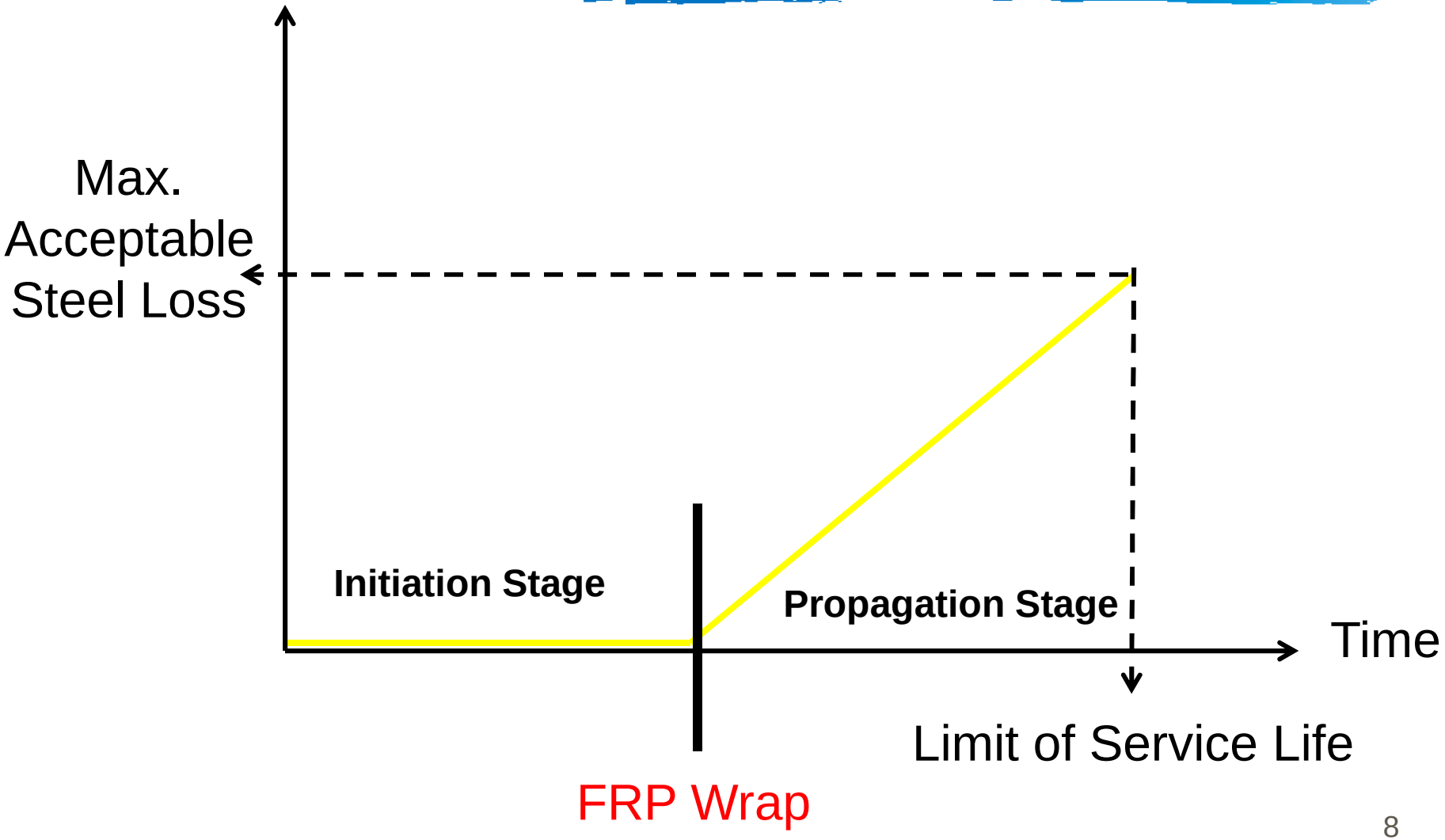
- Background
- Test Program
- Findings
- Field Applications
- Concluding Remarks
- Acknowledgements

Project Goals

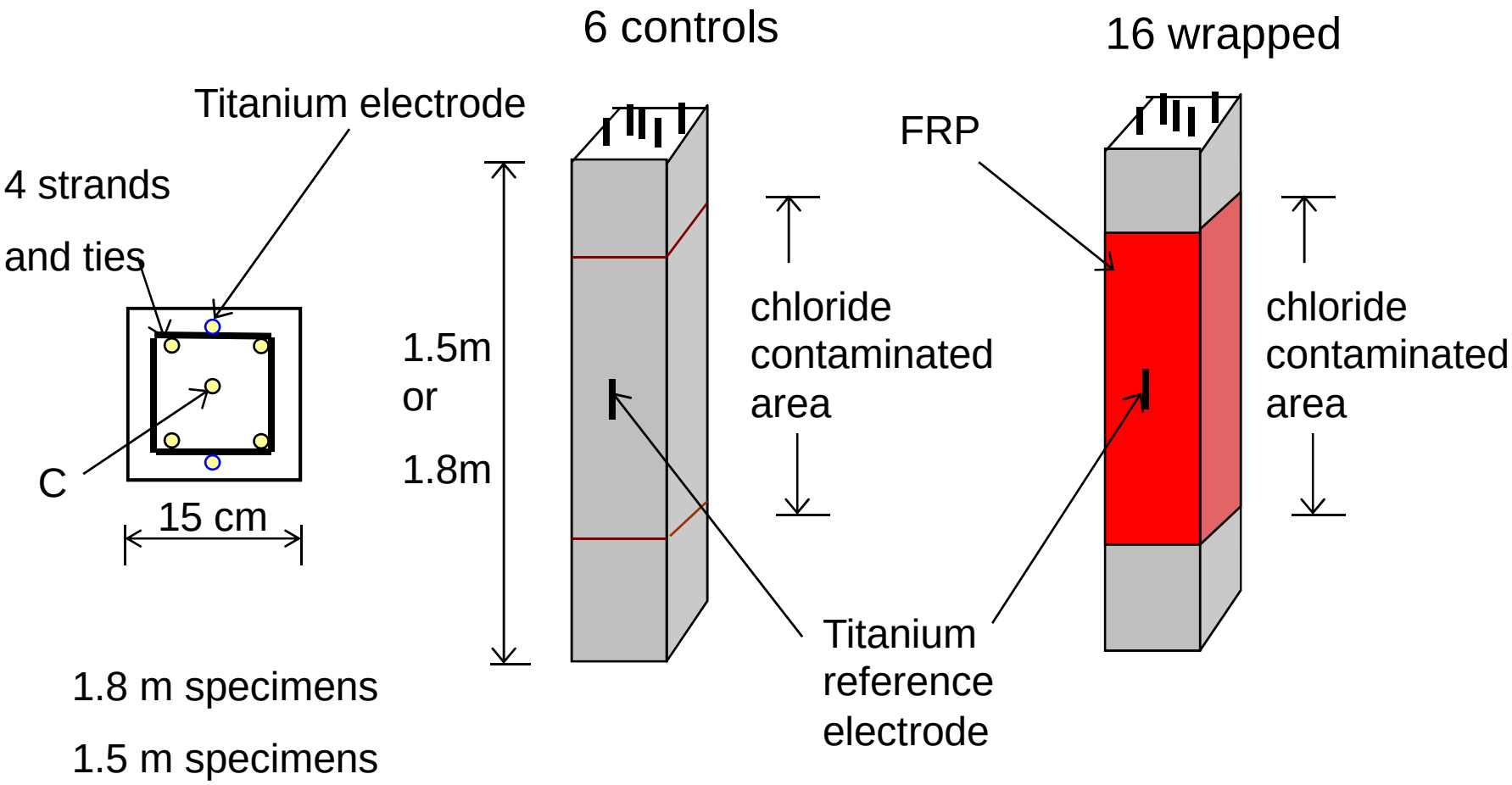
- How effective is FRP in mitigating corrosion?
- How important is the pre-wrap repair?

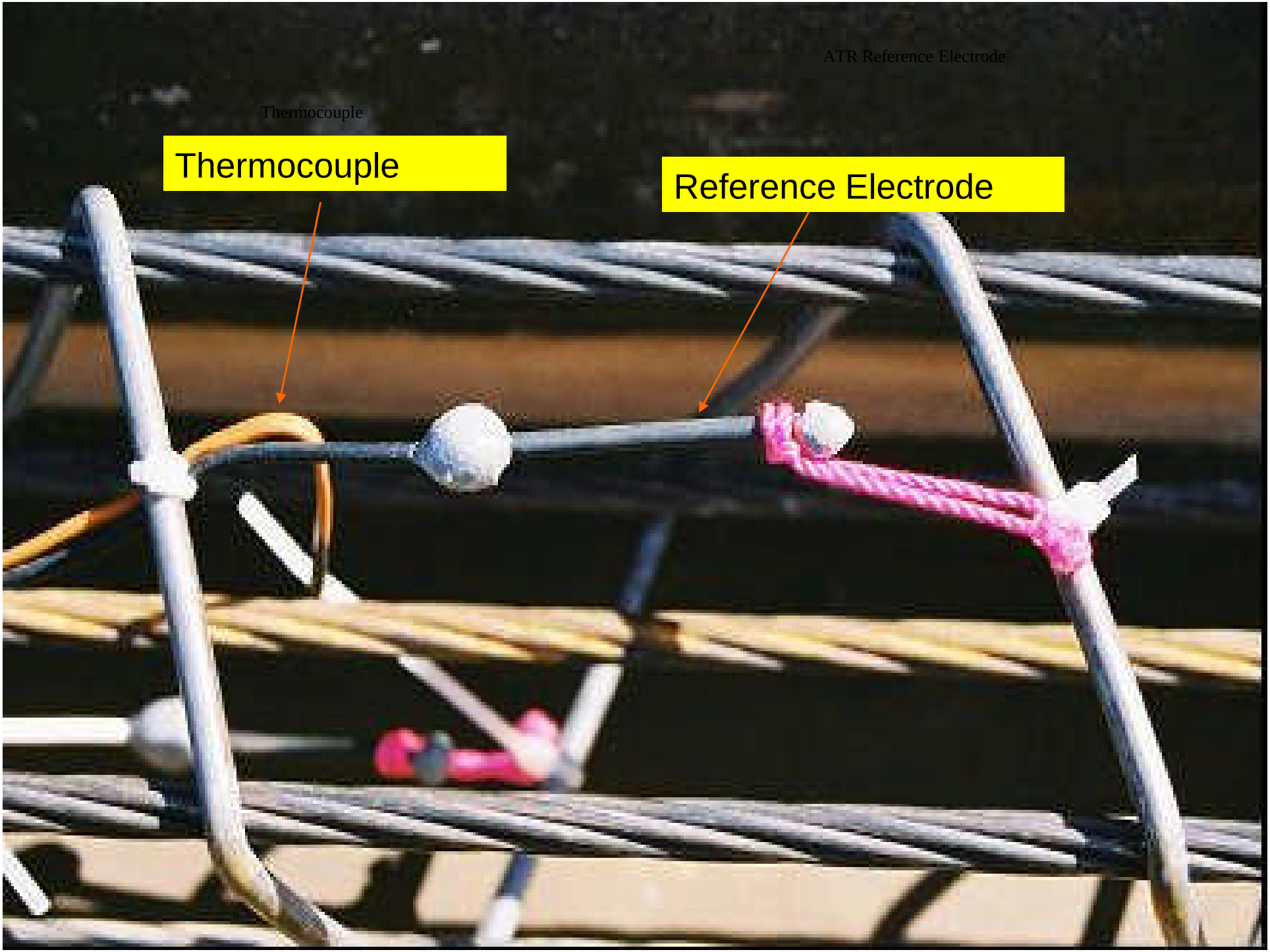
  (Not covered)
- How feasible is it to conduct field repairs?

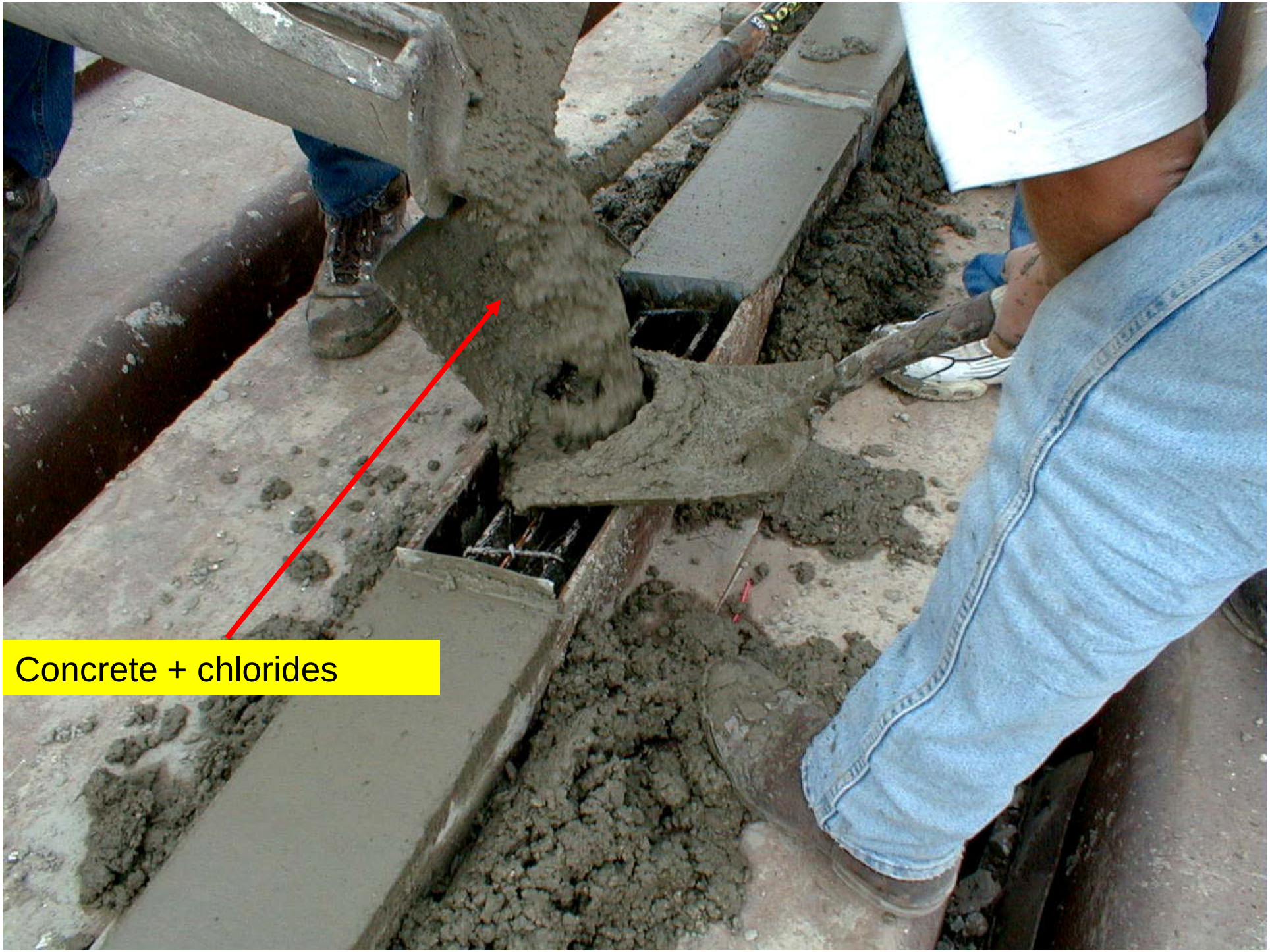
Tuutti's Corrosion Model



Test Specimen




ATR Reference Electrode
Thermocouple
Thermocouple
Reference Electrode


Concrete + chlorides

FRP Wrapping

- 28 days
- Glass
  - 1, 2, 3, 4 layers
- Carbon
  - 1, 2, 3, 4 layers

Carbon Fiber Wrap

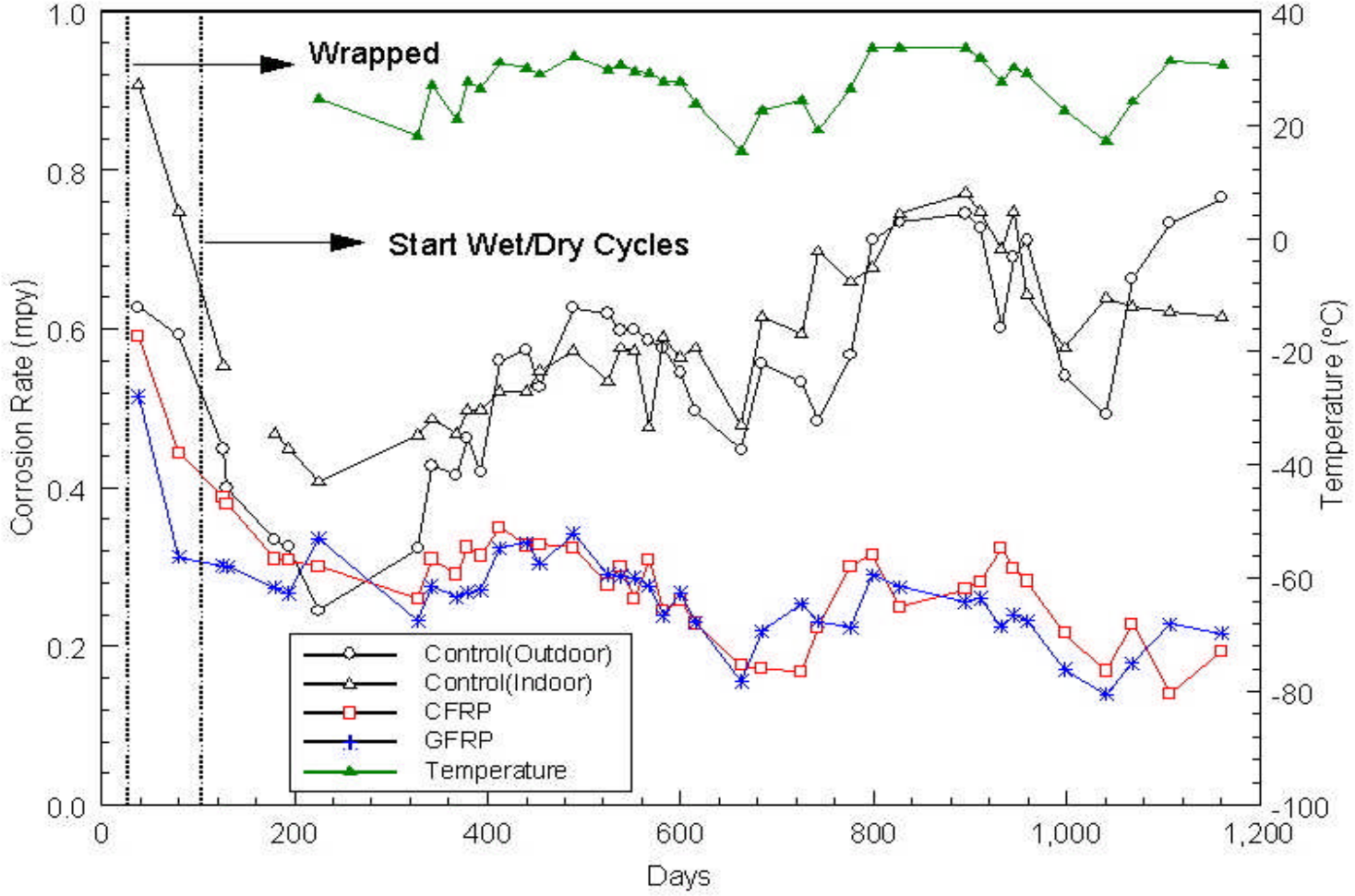
Glass Fiber Wrap

Ambient Exposure

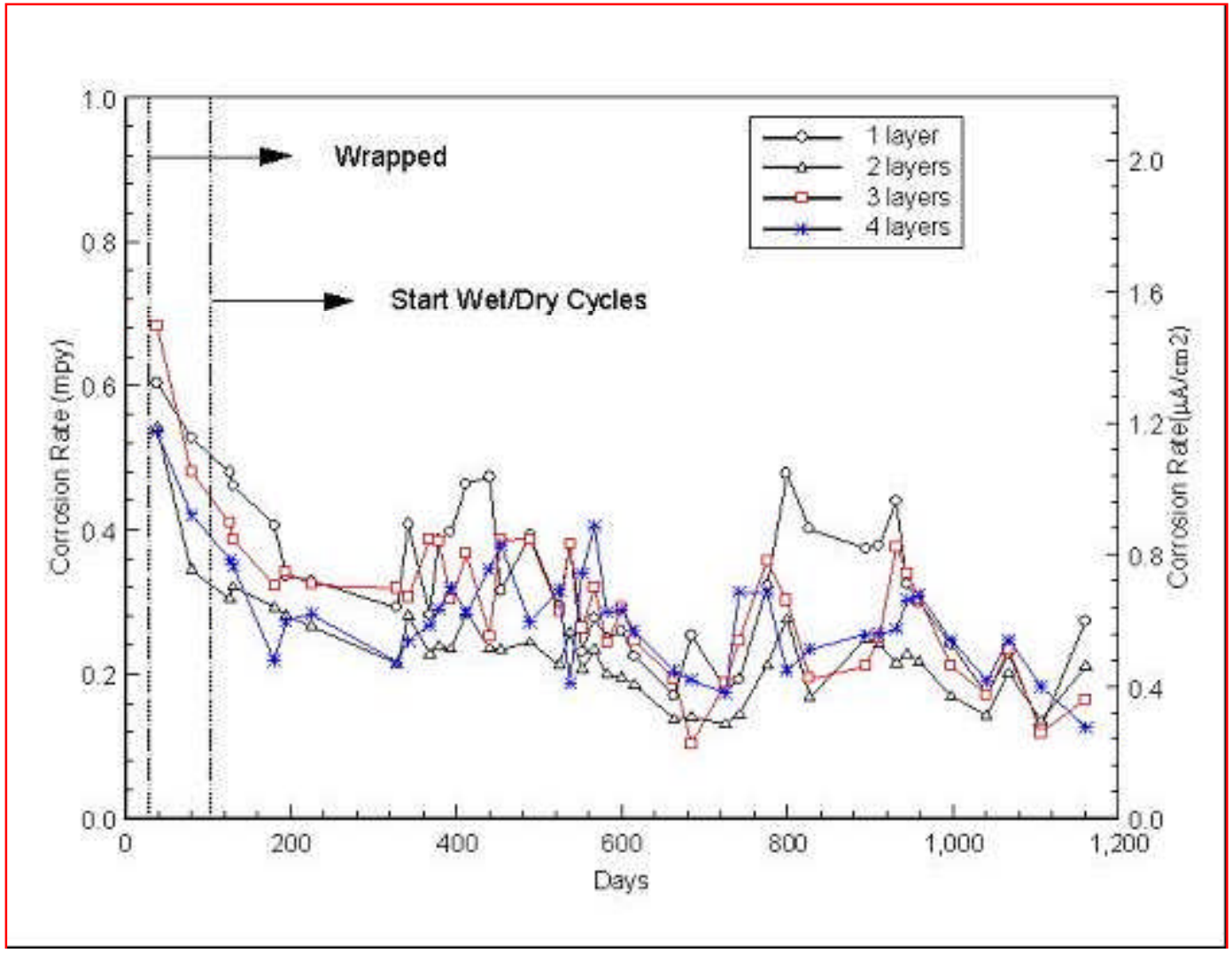
- 3.5% salt water
- Wet/dry cycles: every 6 hrs
- 1160 days (3 yrs 2 months)

Controls vs Wrapped Specimens

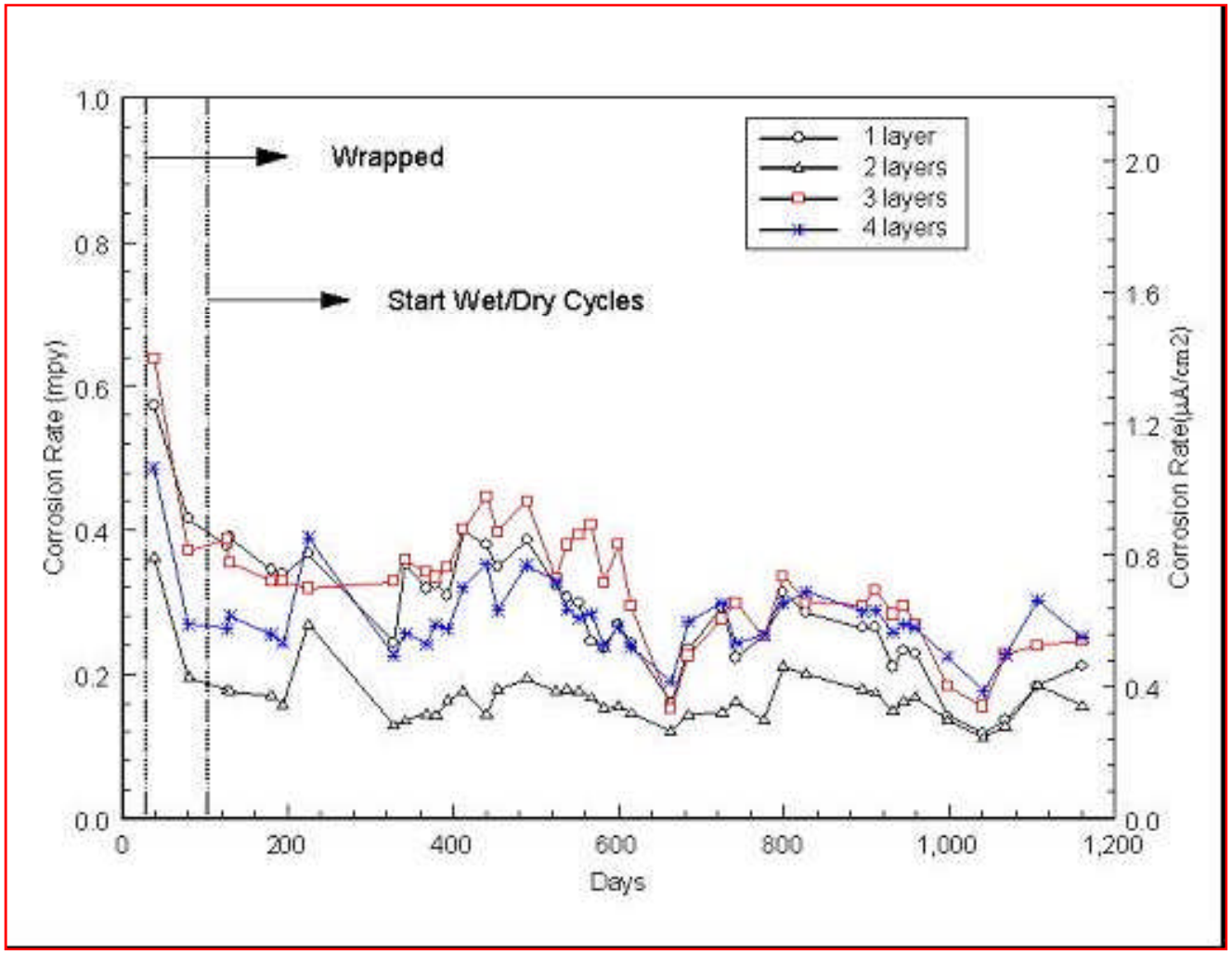
Effect on Corrosion Rate



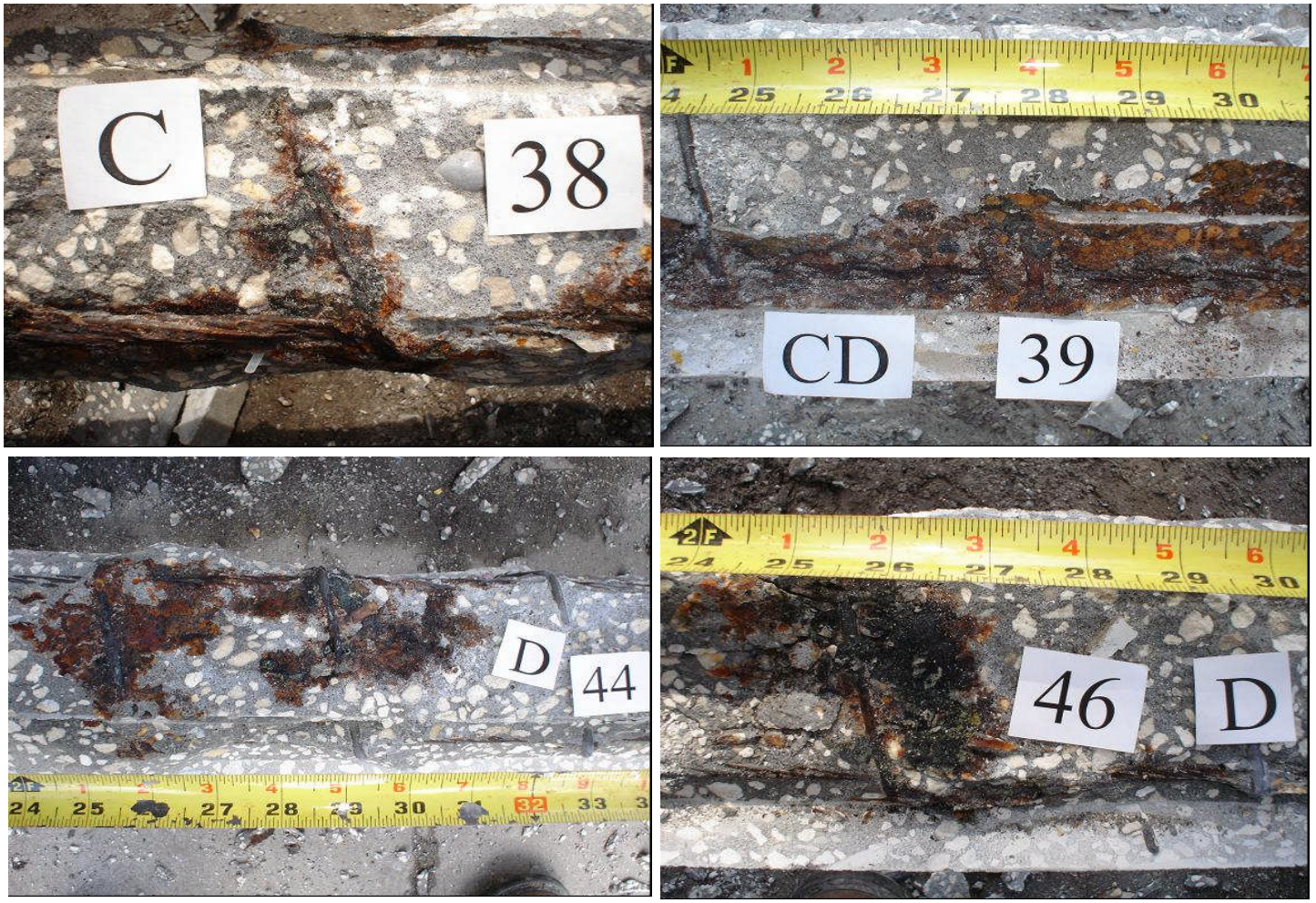
Role of Layers - CFRP



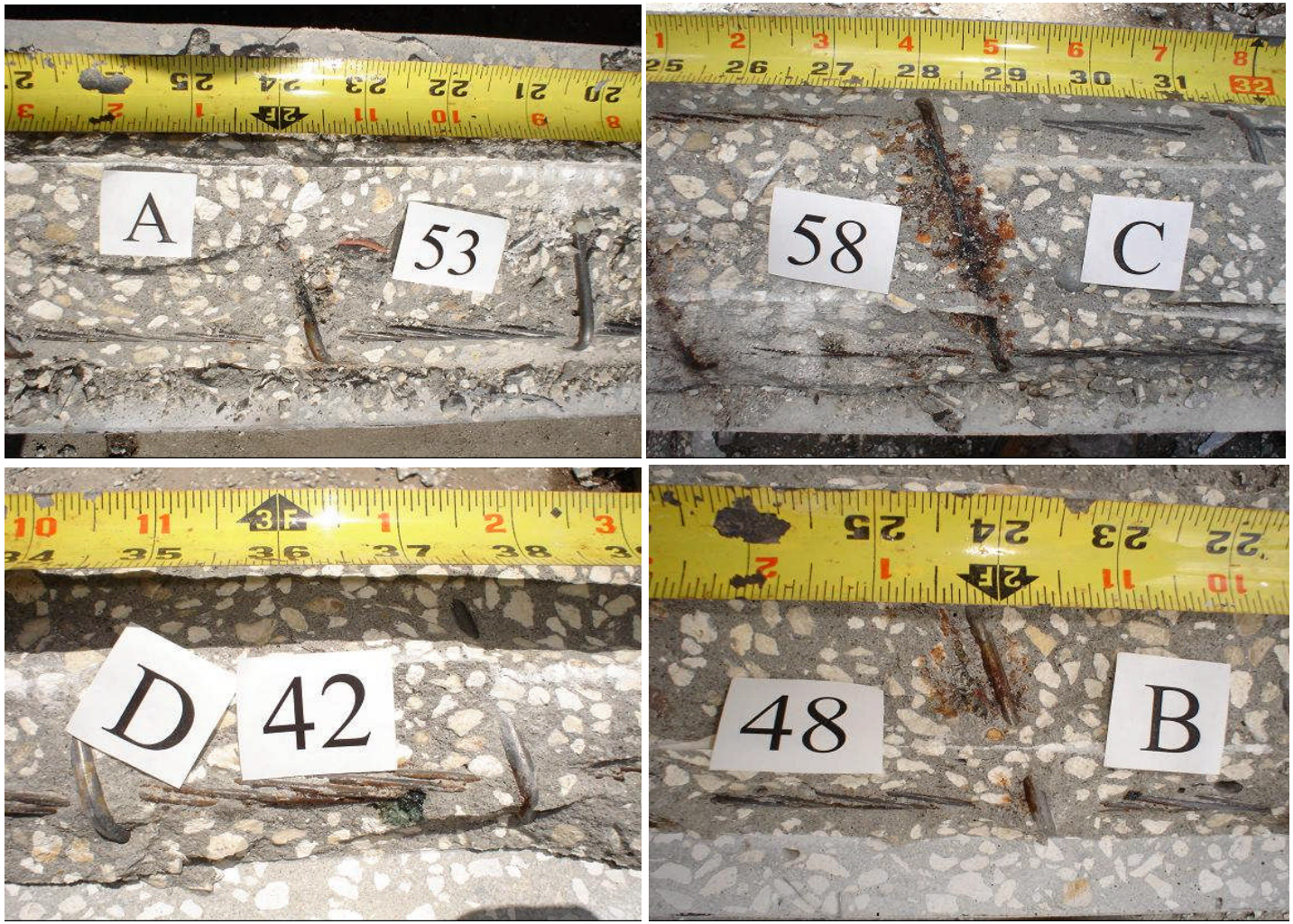
Role of Layers - GFRP



Unwrapped Controls



Wrapped Specimens



Retrieved Strands

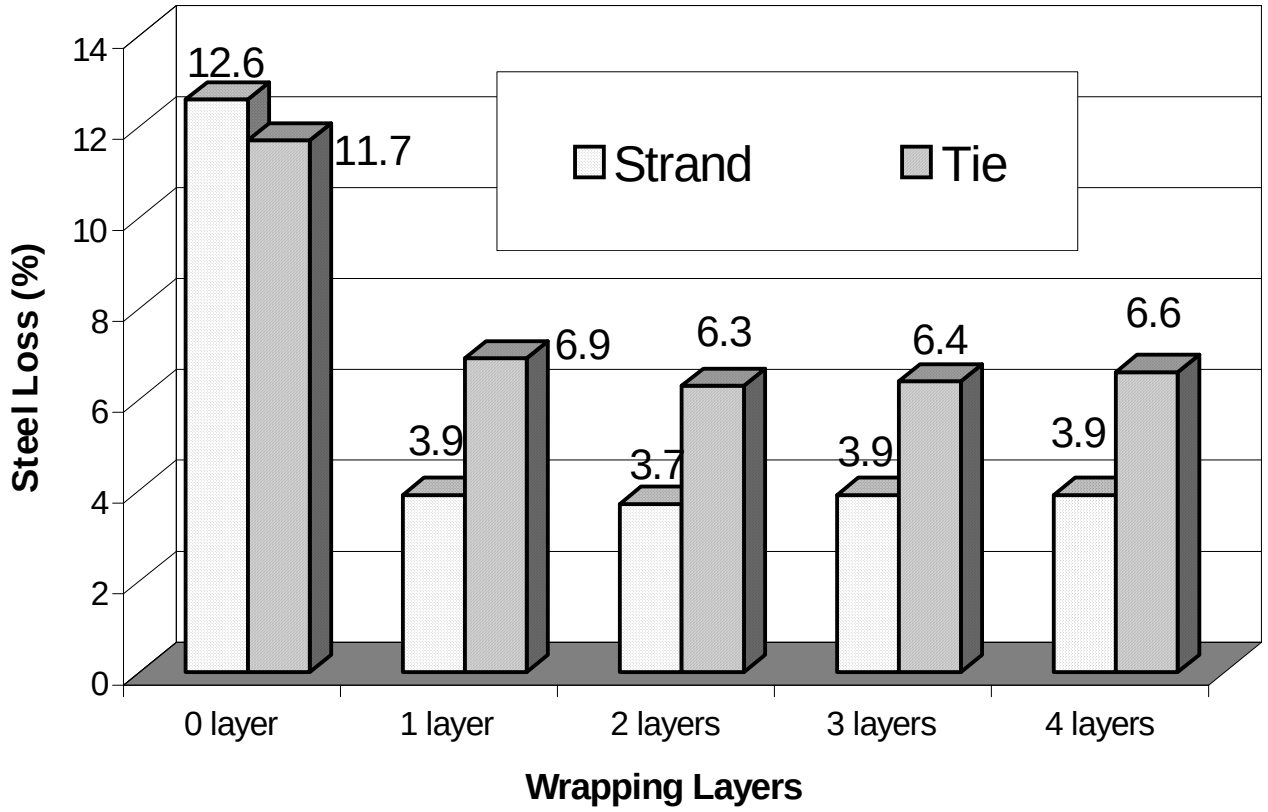
Outdoor Control

30 wire breaks in 6 controls

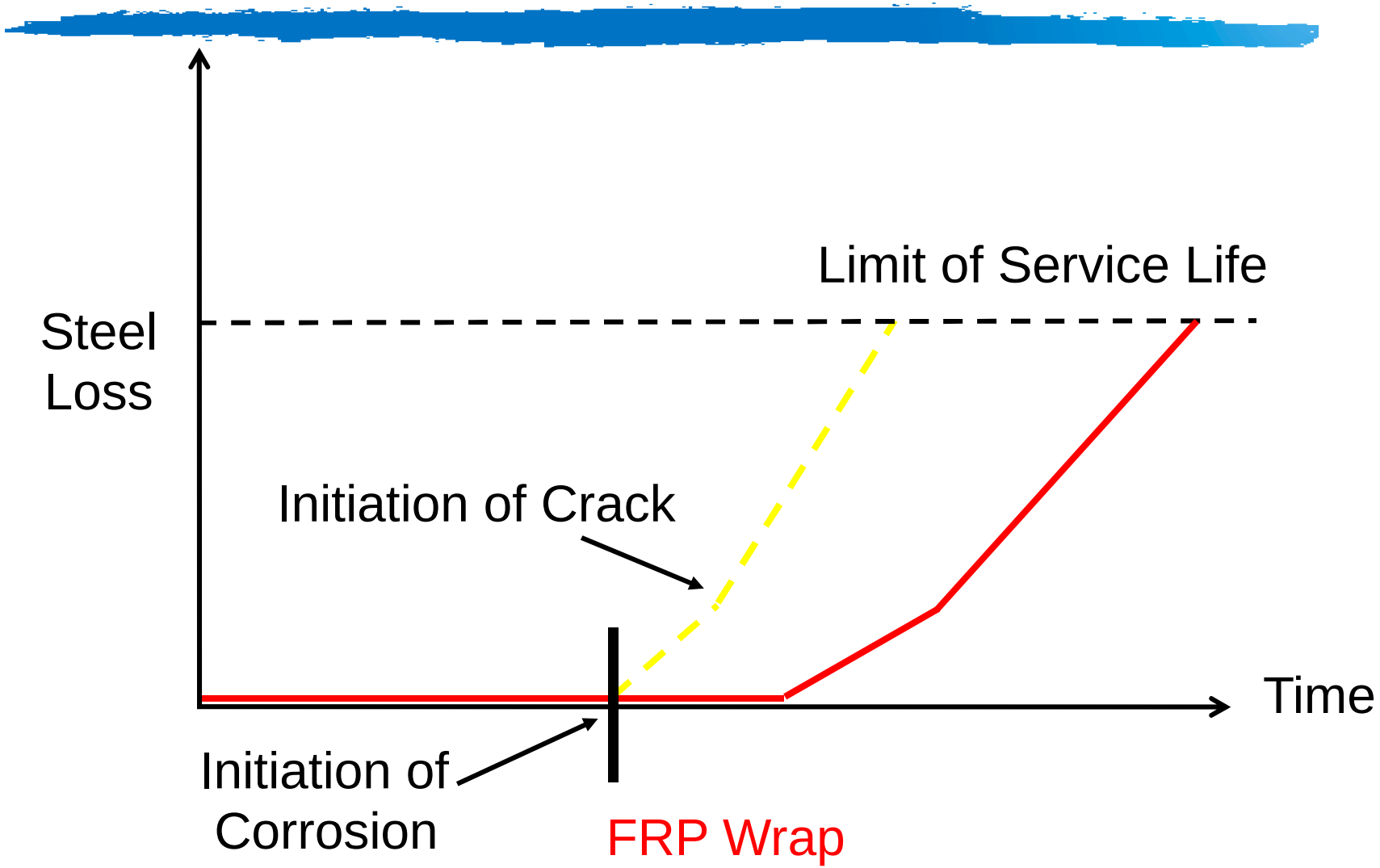
CFRP Wrapped

1 wire break in 16 FRP specimen

1/3rd Metal Loss in Wrapped Specimens

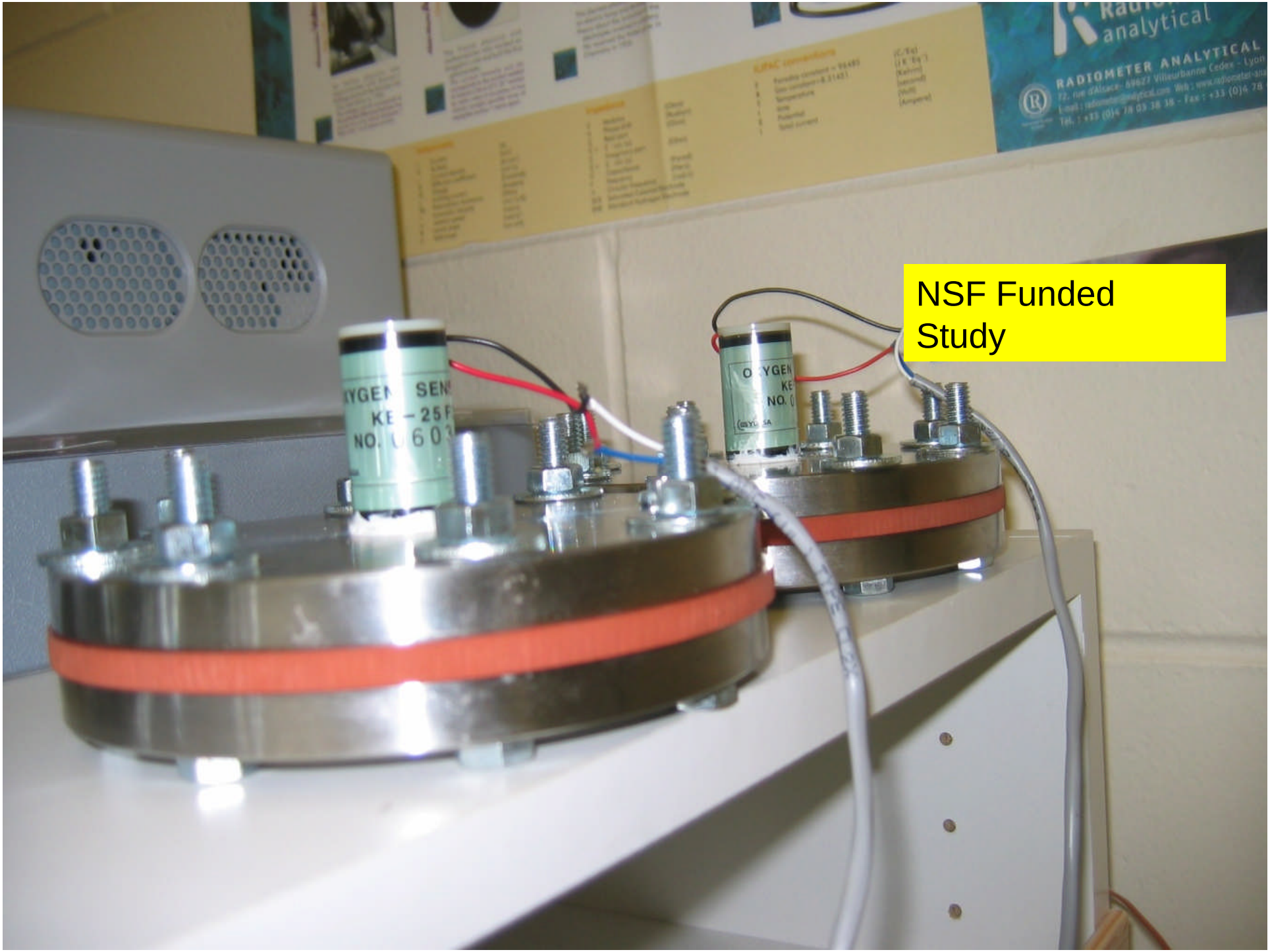


Implications



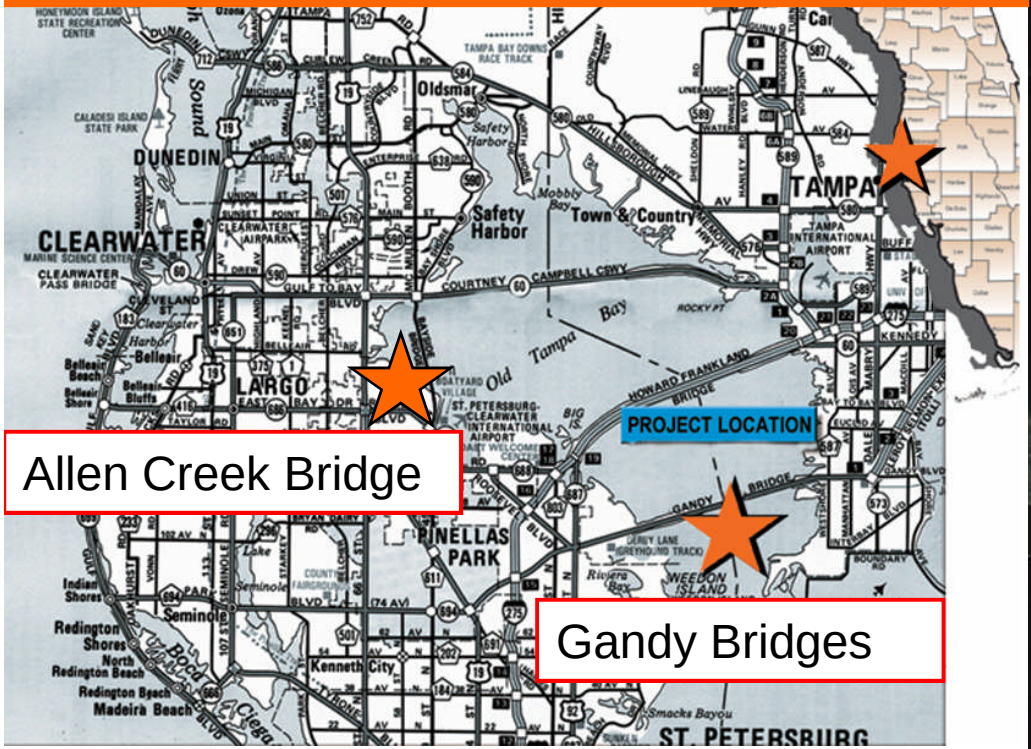
Why?

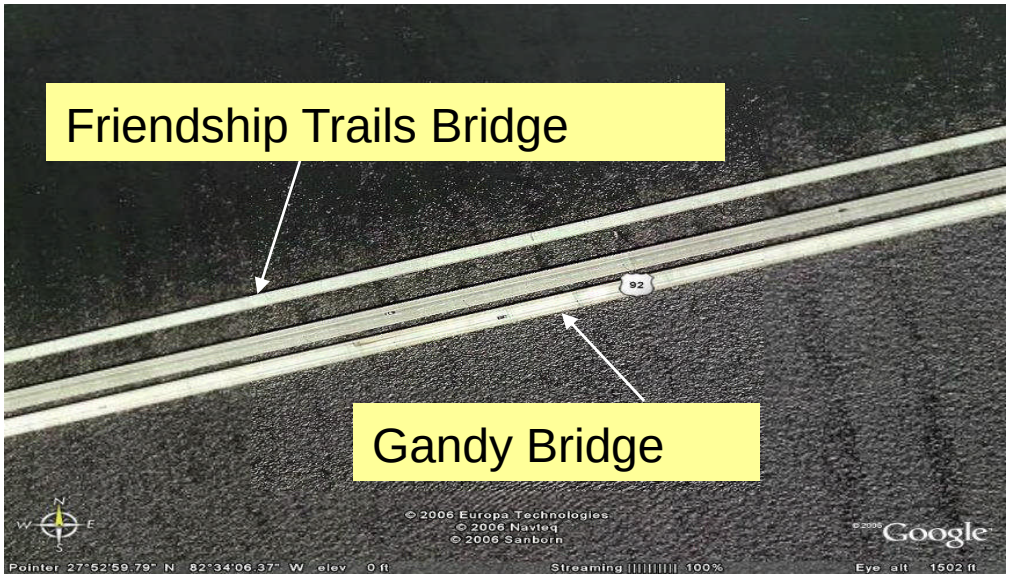
- Tests are underway to evaluate FRP's performance as a barrier
- If possible, we would like to evaluate coatings that could conceivably be used to improve FRP's performance


NSF Funded
Study
RADIOMETER ANALYTICAL

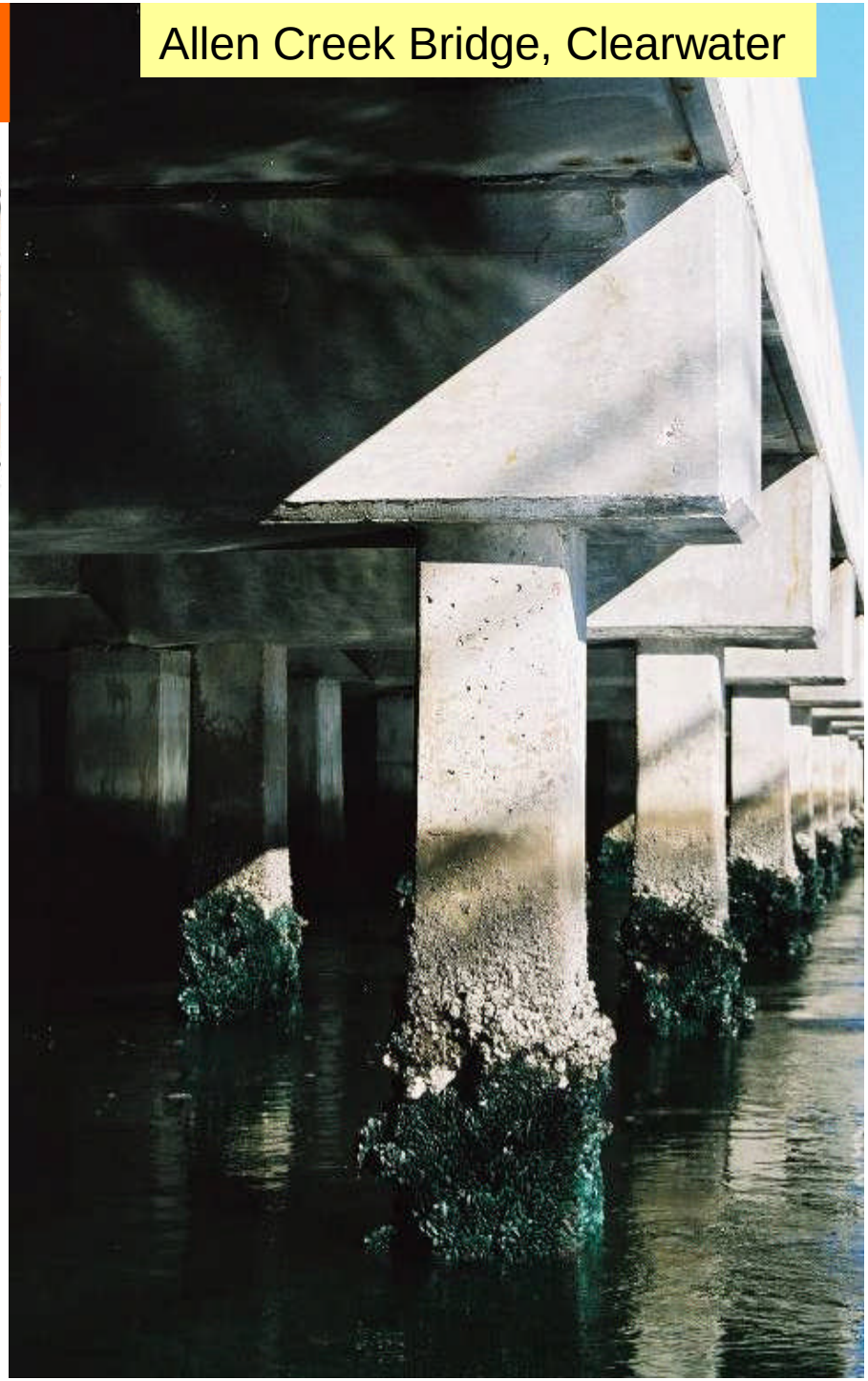
Field Validation

Field Demonstration Studies



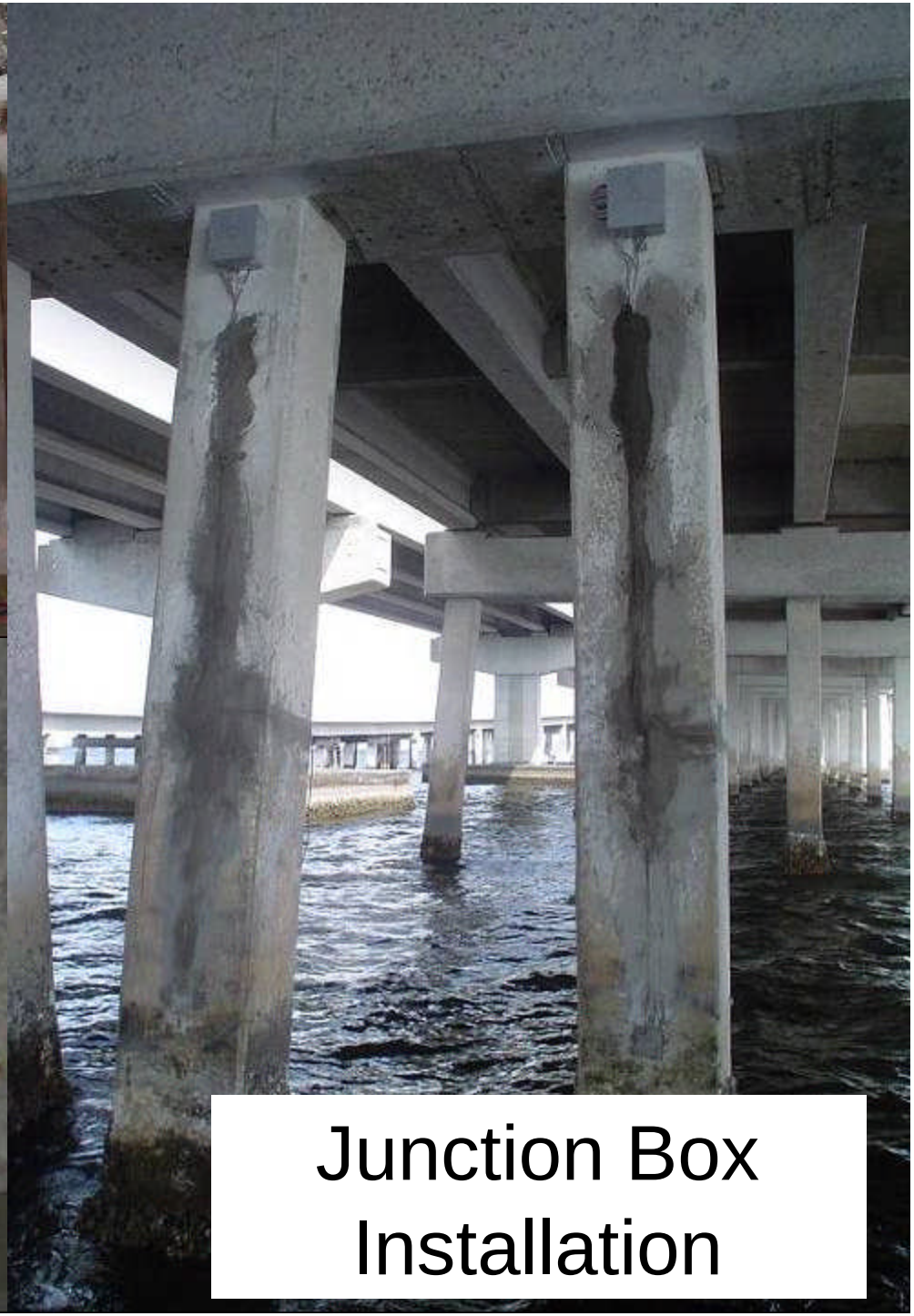


Allen Creek Bridge, Clearwater



Gandy Bridge, Tampa

Linear Polarization



Junction Box Installation

Measured Corrosion Rates in Controls vs Wrapped Piles

Pile	Date	Rate (μm/yr)
Control 91 cm above HWL	Nov 2004	8.39
	Jun 2005	6.77
	Aug 2007	9.46
Control 31 cm Below HWL	Nov 2004	49.6
	Jun 2005	20.48
	Aug 2007	38.48
Wrapped Pile 91 cm above HWL	Nov 2004	18.52
	Jun 2005	7.34
	July 2007	5.75
Wrapped Pile 31 cm Below HWL	Nov 2004	194.09
	Jun 2005	38.82
	July 2007	10.19

Latest Application

Grove Isle Bridge, Miami
January 2009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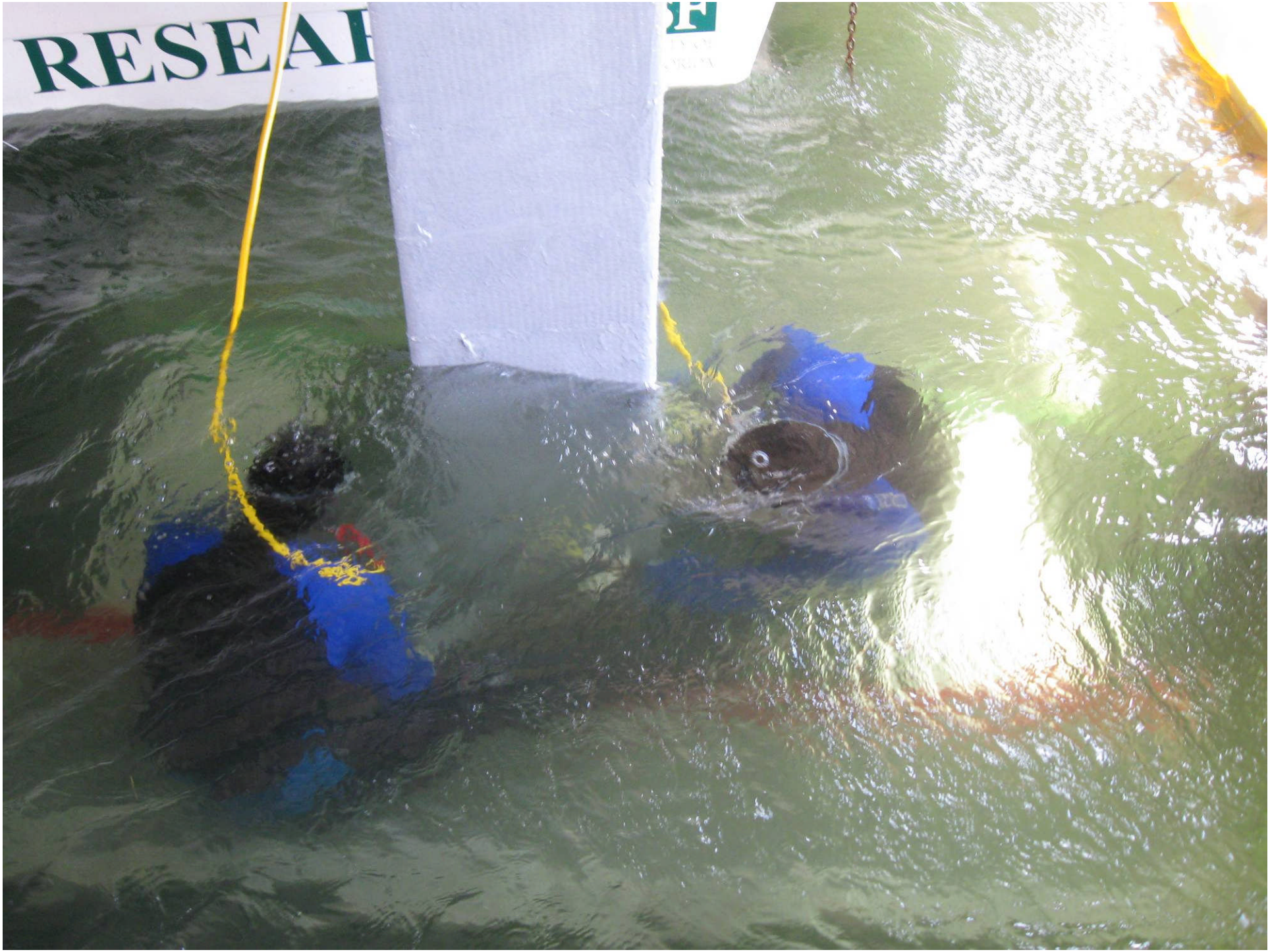
RESEAR

CP + Wrap + Pressure Bag

NCHRP-IDEA-128

Concluding Remarks

- FRP slows down the corrosion rate
- Performance of CFRP and GFRP are comparable
- Performance appears to be independent of number of layers
- Linear polarization correctly predicts trends

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