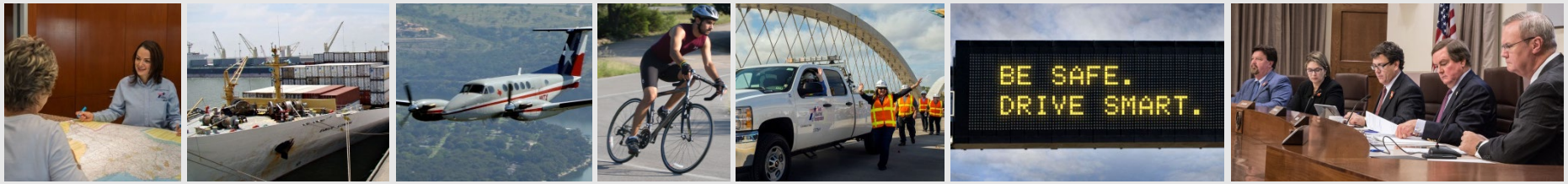
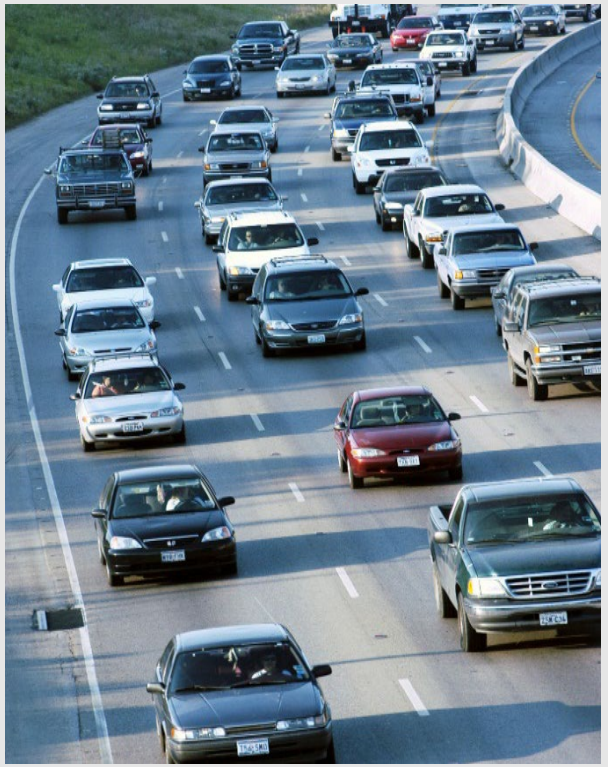


CONCRETE METALIZING ON THE QUEEN ISABELLA CAUSEWAY



Steven Austin

Texas Department of Transportation

April 16, 2019

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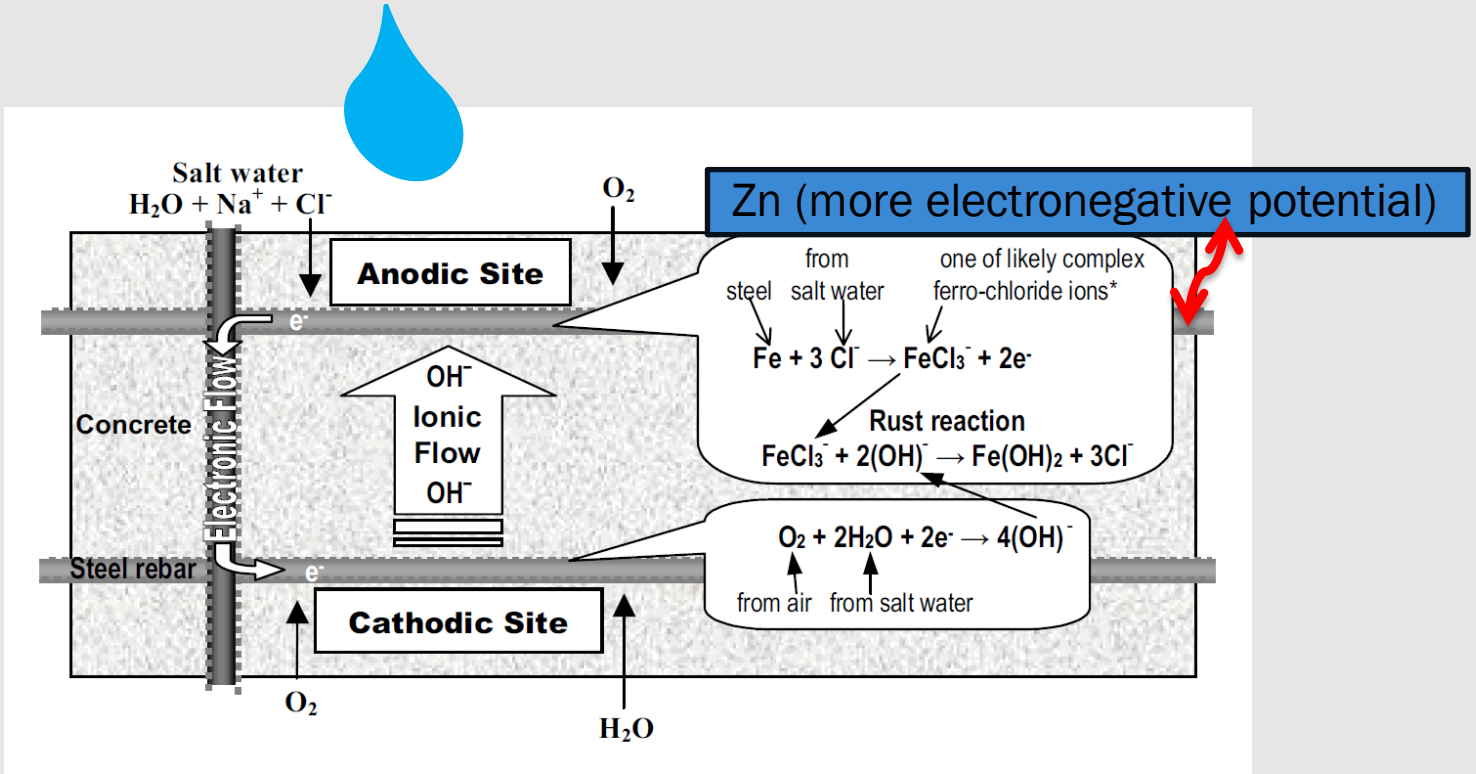
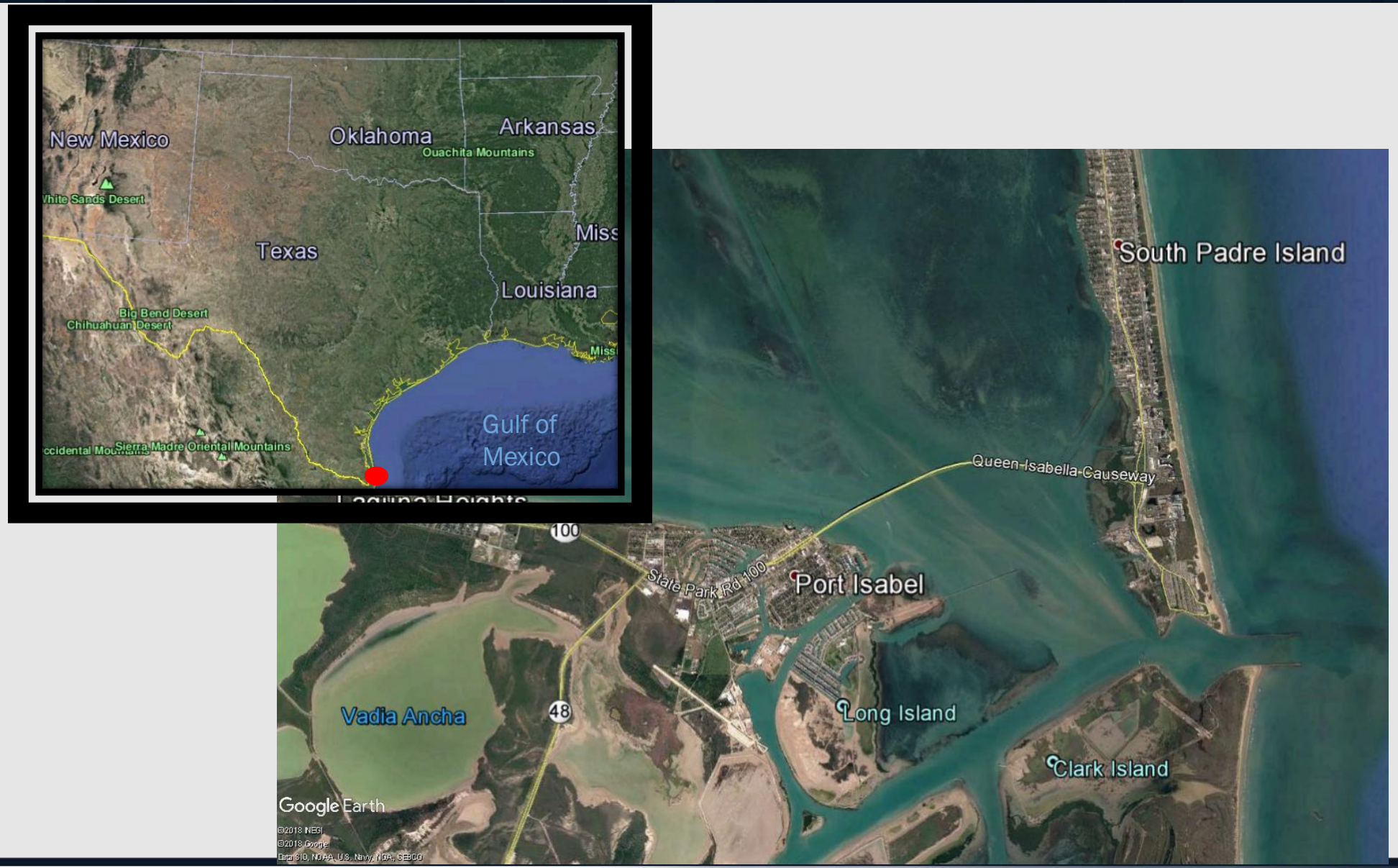
What is Concrete Metalizing?

- Applying a metallic coating to provide increased protection to corrosion of reinforcing through cathodic protection.
- Usually applied in salt-rich environments.
- FHWA research has shown that metalizing can outperform many other coatings.
- Some resources suggest a +25 year life for metalized coatings.
- In marine environments these systems may have a reduced service life.
- Metalizing can be effective with passive system or impressed current system.

What is Concrete Metalizing?



Queen Isabella Causeway



Queen Isabella Causeway

- 12,521’ Long Bridge Constructed in 1974
- 147 - 80’ simple P.S. concrete beam approach spans
- 3 span – 750’ Continuous Steel Plate Girder Unit
- 67.75’ overall width
- Bridge has had several preservation type projects

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1996 Demonstration Project

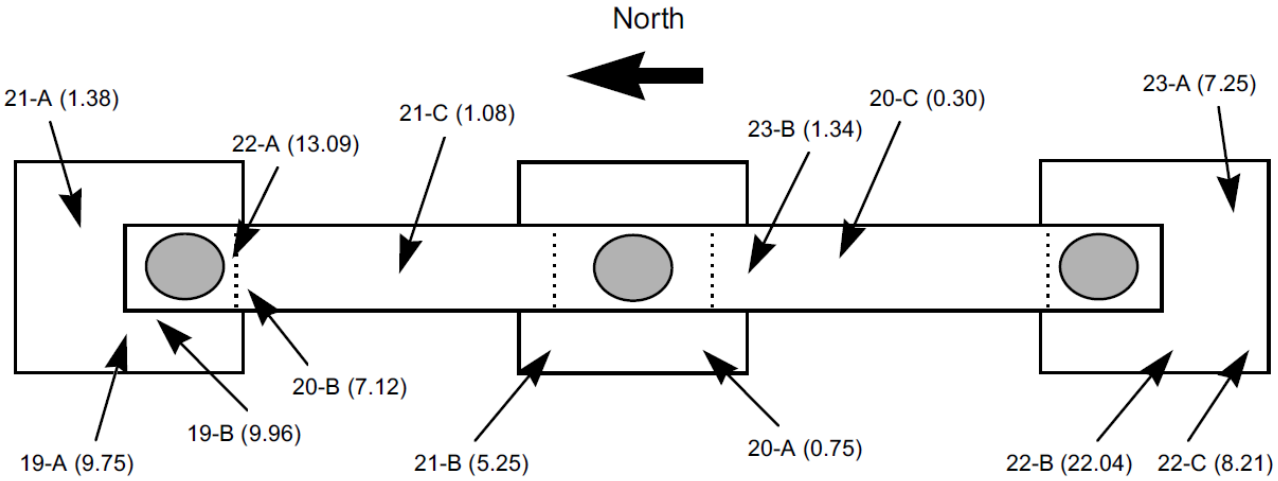
- FHWA/TxDOT Demonstration Project
  - Bent 19 – Thermally sprayed zinc anode with impressed current - anticipated to have a 12 yr life
  - Bent 20 – Thermally sprayed titanium anode with impressed current – anticipated to have a 40 yr life
  - Bent 21 – Titanium mesh concrete overlay
  - Bent 22 – Thermally sprayed zinc anode without impressed current

1996 Demonstration Project

- Cover meter readings indicated cover over 3.5”
- Various crack widths from 0.03” to 0.125”.
- No delaminations identified

1996 Demonstration Project

- Half-cell potential readings correlated well with cracks.
- Moderate to very high chloride content at reinforcing level.
- Application of metalizing to splash zone only



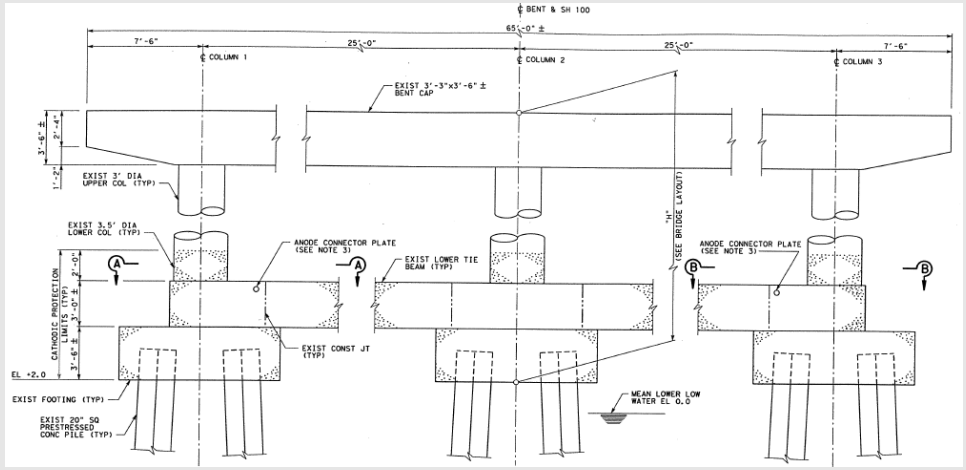
Notes:
First number represents bent location where chlorides were taken
Letter next to first number is the sample identification for a given bent
Number in parentheses are the chloride contents at the level of the reinforcing steel expressed in lb/yd^3

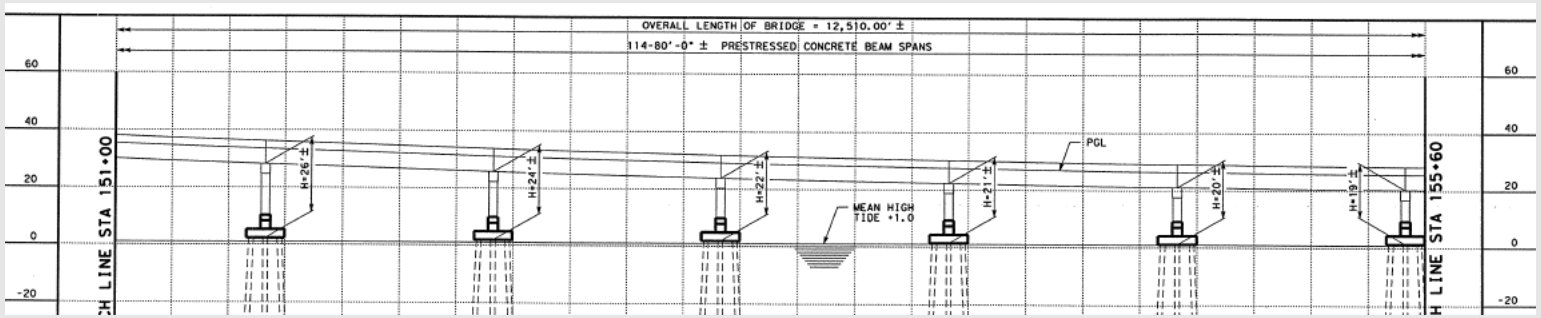
1996 Demonstration Project

- Project Findings:
  - The two systems with the highest service life costs showed premature deterioration in the performance evaluation
  - Sprayed zinc provided the highest productivity of installation
  - Sprayed zinc provided the most economical option

2004 & 2005 Cathodic Protection Projects

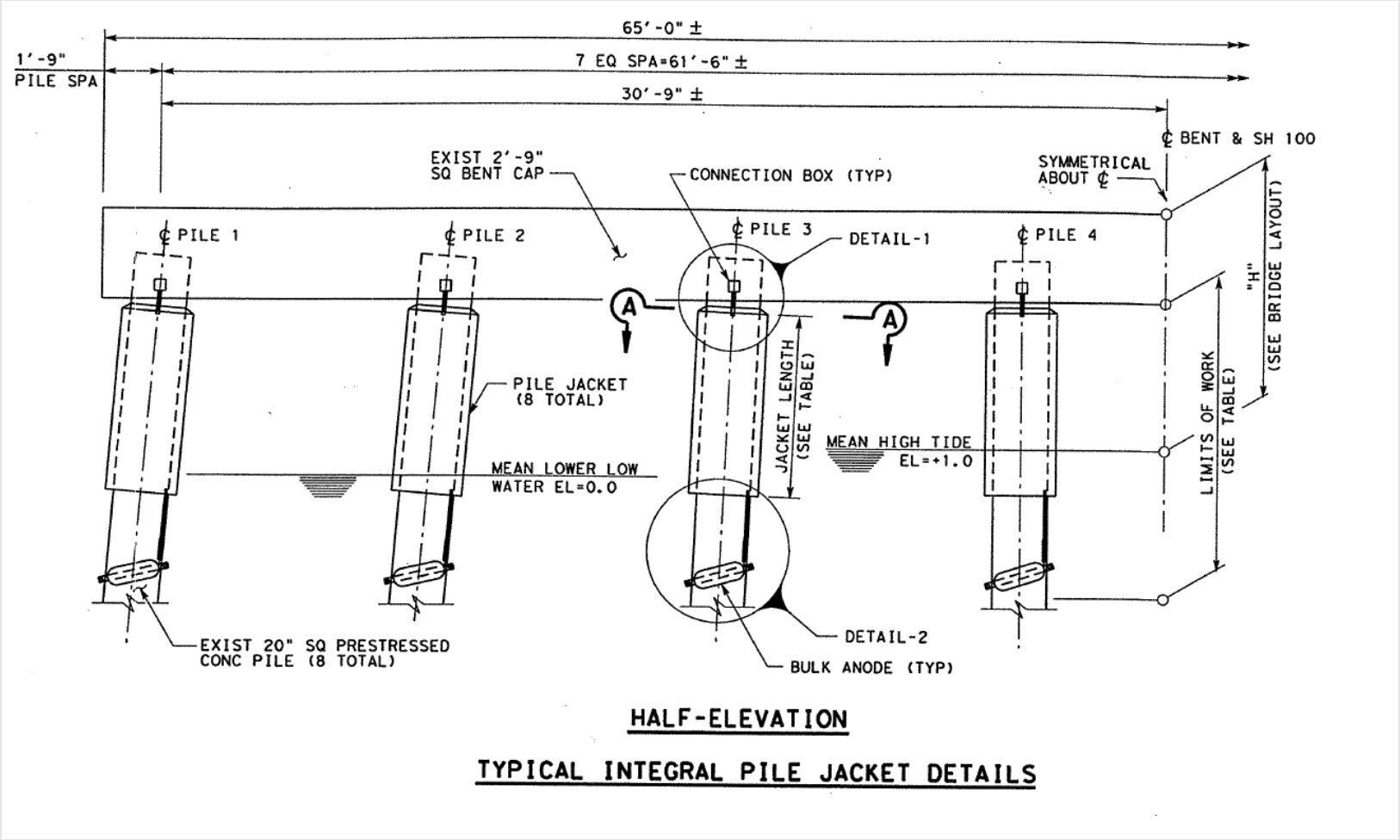
- 2004 Metalizing
  - Zinc coating – 15 mils applied to 72 bents
  - Aluminum (Al-Zn-In) – 12 mils applied to 14 bents
- 2005 Metalizing
  - Zinc coating to remainder of 57 bents with pile caps





2004 & 2005 Cathodic Protection Projects

- 2004 Jackets with Bulk Anodes Bents 1 to 7 and 140 to 151



2009 Assessment

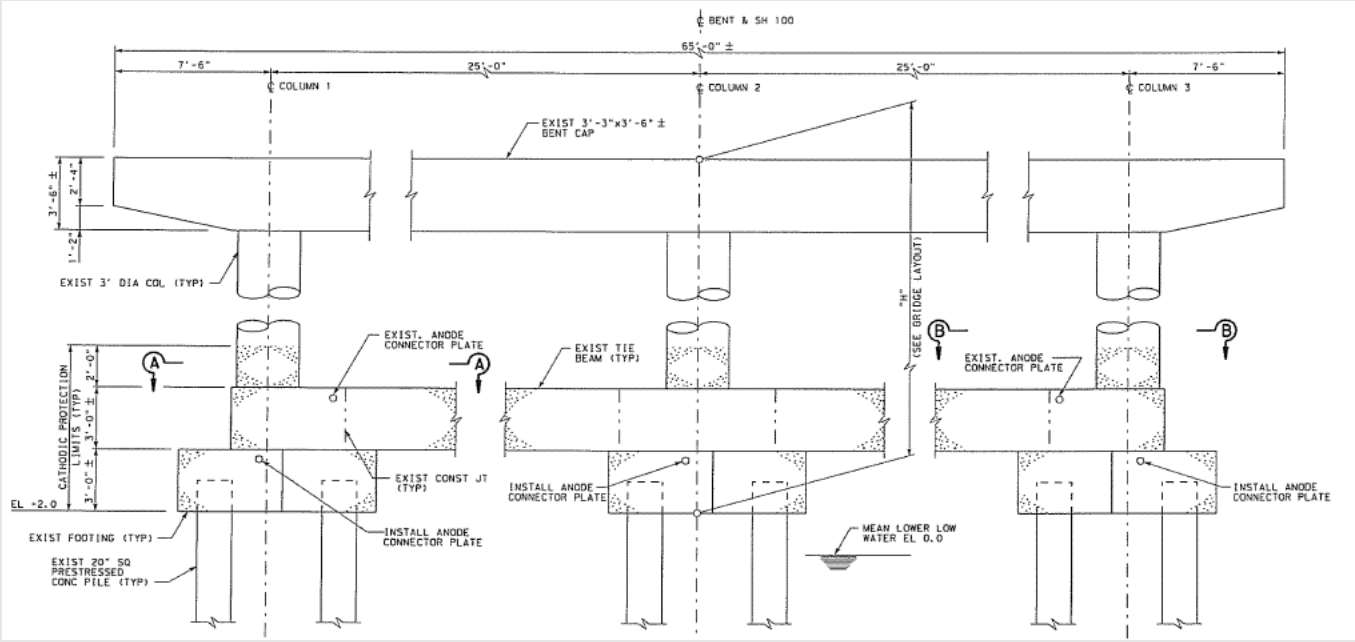
- Assessment to determine effectiveness and remaining life of bridge
- Cathodic protection was effective
- More rapid average consumption of the Al coating compared to the Zn coating
- Recommended re-application to the aluminum-coated bents

2009 Assessment

- More rapid consumption of the anode at the connection to reinforcing. Loss of this connection could result in loss of effectiveness
- 5 years after installation assessment estimated service life of metalizing protection of 10 to 15 years of service life.

2011 Metalizing

- Removed Aluminum alloy metalizing previously applied at some bents and replaced with Zinc coating
- Installed new anode connector plates at nearly all other locations



2018 Assessment

- Found Zn metalizing of 2004/2005 to be completely consumed at some locations.
- 2011 TSZ had nearly twice as much coating blistering as did the 2004/2005
- Half of the 2004/2005 bents tested showed ineffective cathodic protection based on Polarization Testing and Half-Cell potential.

2018 Assessment

- Recommended re-application of metalizing at $9.5M to provide service life of 20+ years

2018 Assessment

- TxDOT review
  - Extensive literature research on metalizing and corrosion evaluation and mitigation plans
  - June 20 and 21, 2018 field trip by TxDOT employees using resistivity meters and coating sampling.
  - Visual assessment confirmed areas of no remaining metalizing at various locations
  - Approaching end of useful coating life after 7 years at locations coincident with what appears to be poor construction quality (honeycombing).

2018 Assessment

- TxDOT review
  - Resistivity readings of 11-70 kΩ-CM in many footings.
  - Some top of footing readings were in the single digits.
  - Corrosion is active
  - 2011 application is also approaching the end of the useful life

2018 Assessment

- TxDOT review
  - The use of bulk zinc anode for Bents 1 to 7 and 140 to 151 appears to be quite effective
  - The cathodic protection at these bents is still effective with protection extending into the bent caps.

Summary of Findings and Recommendations

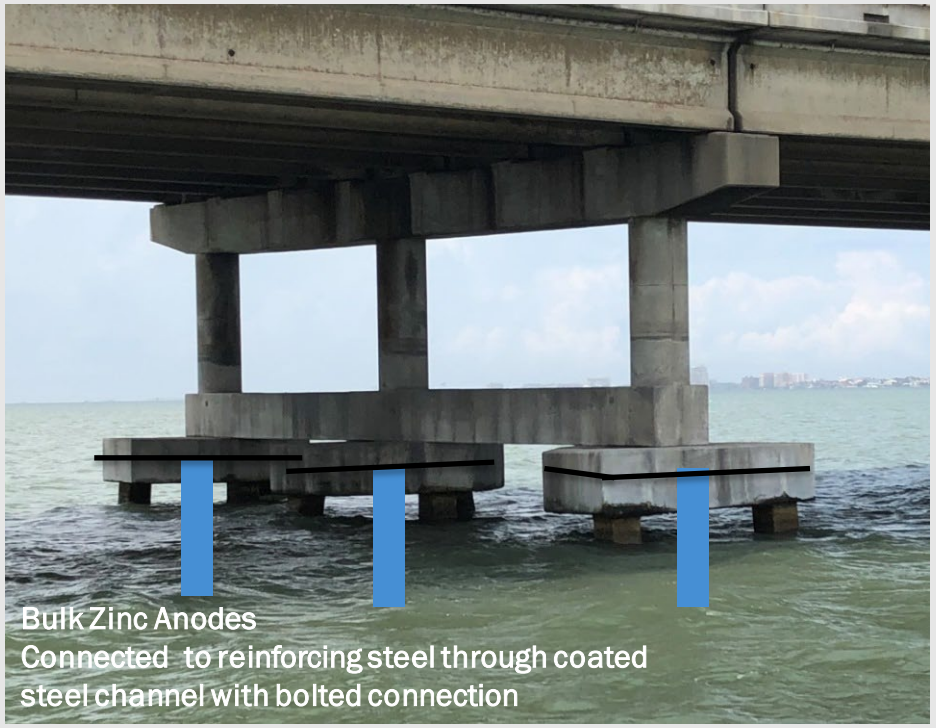
- Performance is not as effective as anticipated likely due to splash zones contributing to quicker consumption of metal coating.
- Life expectancy of TSZ is greater than TSA.
- 15 year life may be achieved but in the case of QIC, new anode connector plates were required after 6 or 7 years.
- Not as effective at mitigating corrosion under conditions of poor construction quality
- Second application is not as effective due to more loss of surface mortar removed during surface preparation.

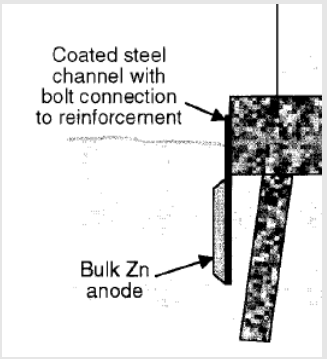
Summary of Findings and Recommendations

- To address poor construction quality issues in splash environments, consider GFRP jackets with buried zinc anodes in lieu of concrete metalizing.
- To provide protection against corrosion in **coastal splash environments**, install submerged bulk zinc anodes after performing concrete repairs in lieu of metal coating.

Summary of Findings and Recommendations

- Submerged Zn bulk anodes appear to be a low cost, technically viable option for corrosion control on substructures of the type investigated
- Include monitoring system to ensure the proposed system is working.
- Estimate $3M for installation and monitoring system on all pile caps.





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