Distributed Galvanic Anode Systems to Improve the Service Life of Slab Bridge Abutment Repairs

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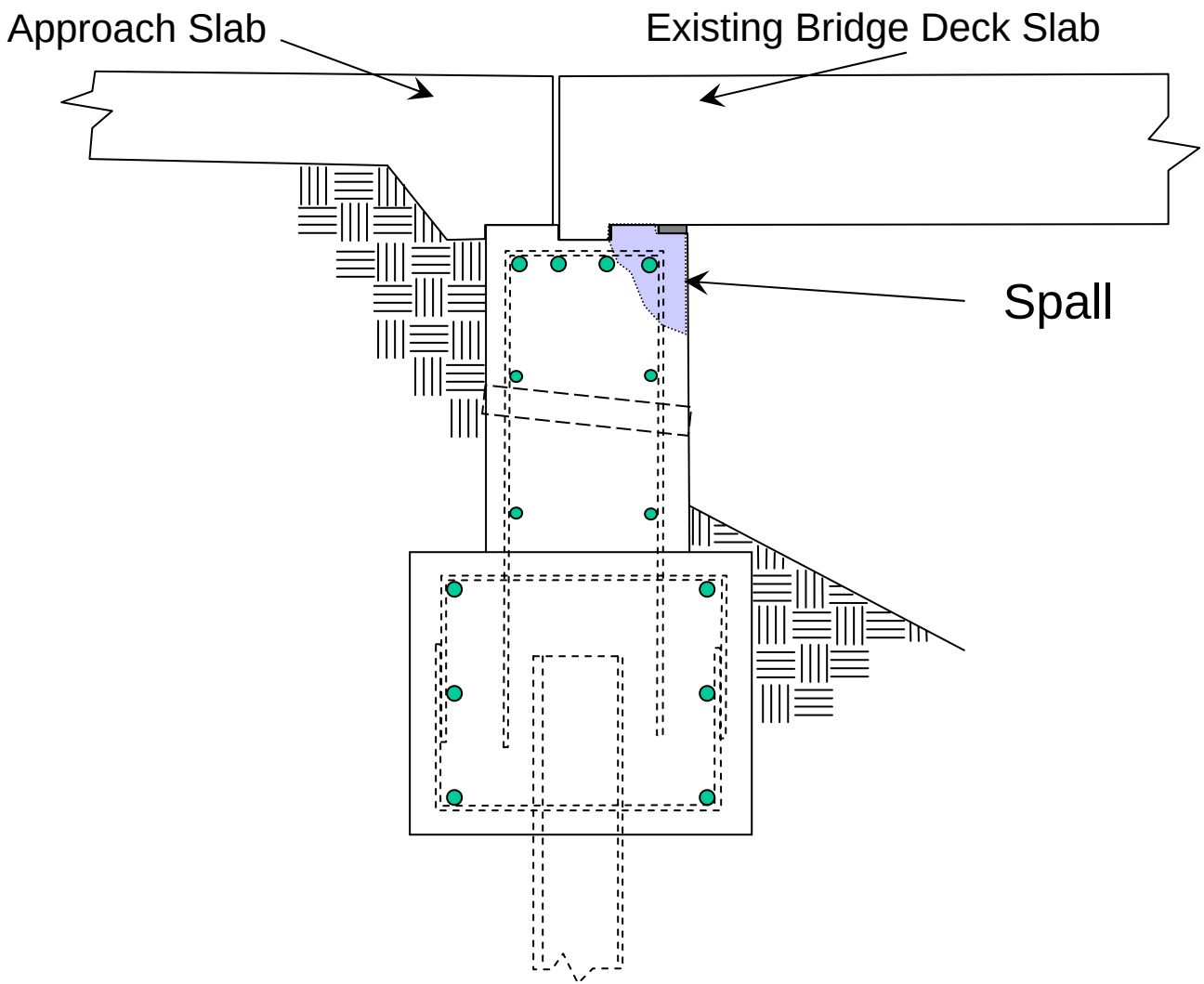
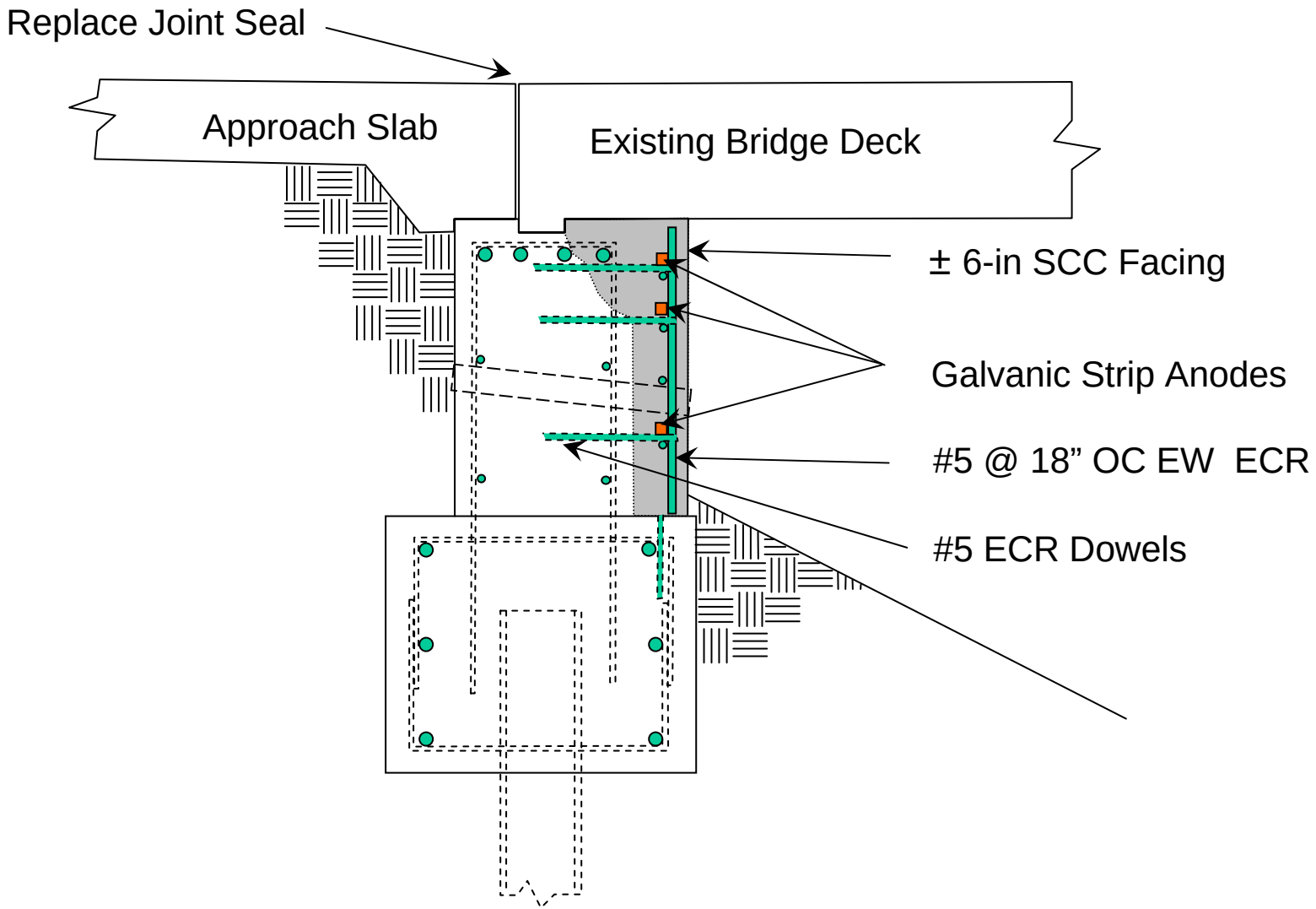
Typical Slab Bridge Abutment

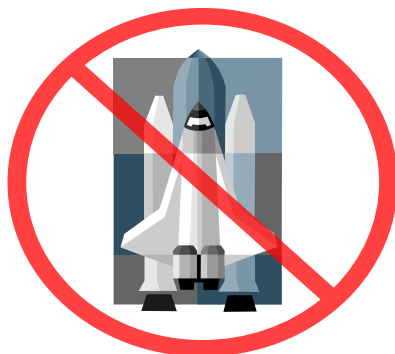


Abutment Repair Detail With Galvanic Protection

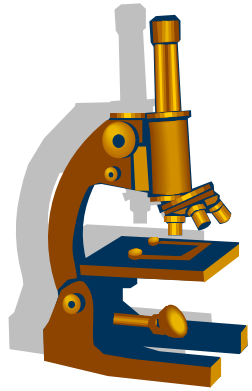


Galvanic Protection Systems

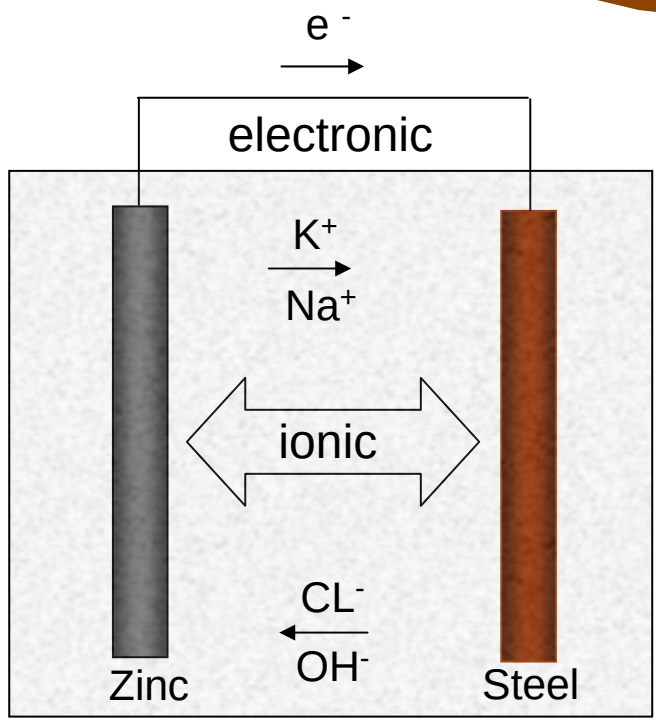
- Two different metals are connected in same electrolyte (concrete)
- More “active” metal = anode
- More “noble” metal = cathode
- Anode corrodes to protect cathode
- Natural reaction
  - no external power required
- Safe for prestressed concrete



Potentials and Current Flow



Partial Galvanic Series	
<u>Metal</u>	<u>Voltage</u>
Zinc	-1100 mV
Steel in concrete	-200 mV to -500 mV
*Typical potentials measured with respect to copper-copper sulfate electrode	



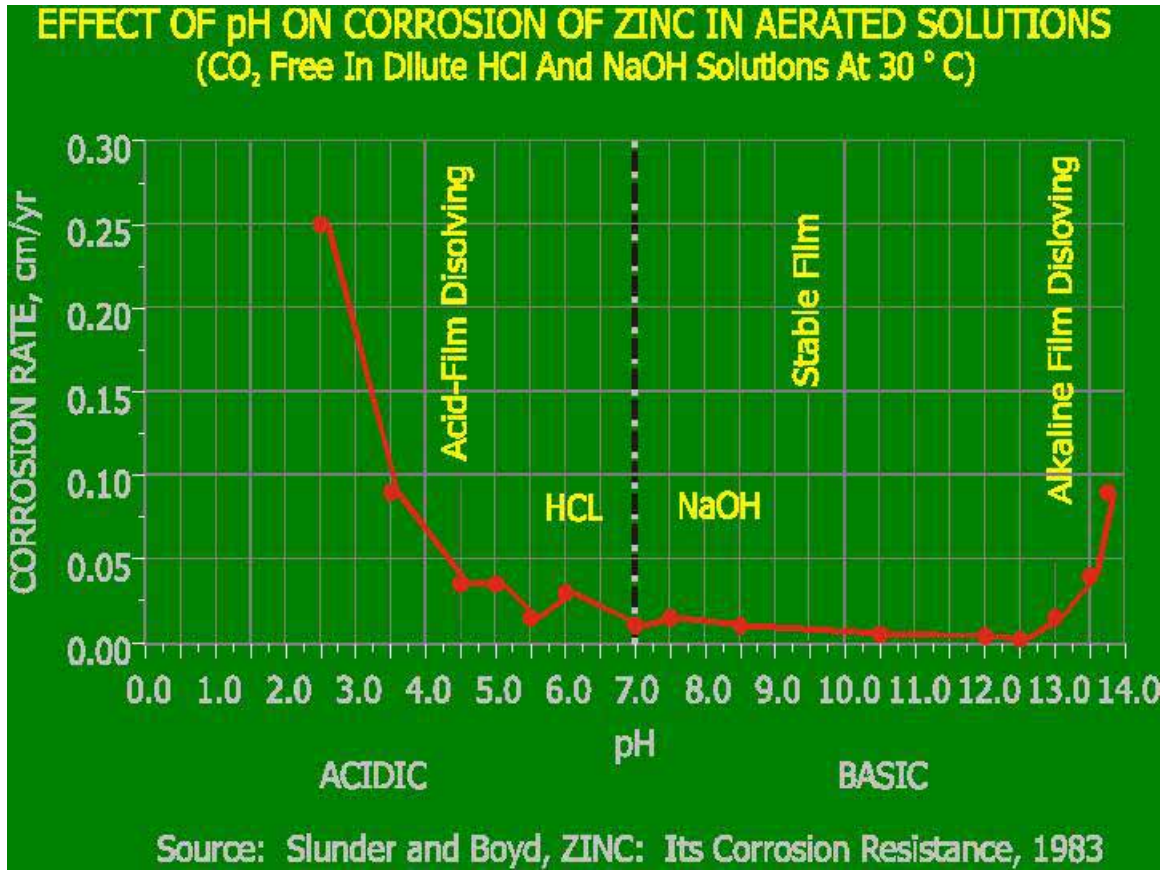
Distributed Galvanic Anodes

- Distributed anode units are pre-manufactured
  - Zinc around a steel core
  - Integral connections
- Typical sizes
  - 0.2 to 2.0 lb. of zinc per lineal foot of anode
  - Up to 7.5 ft in length
- Anode size and spacing: based on steel-to-concrete surface area ratio and service life

Activation Technology

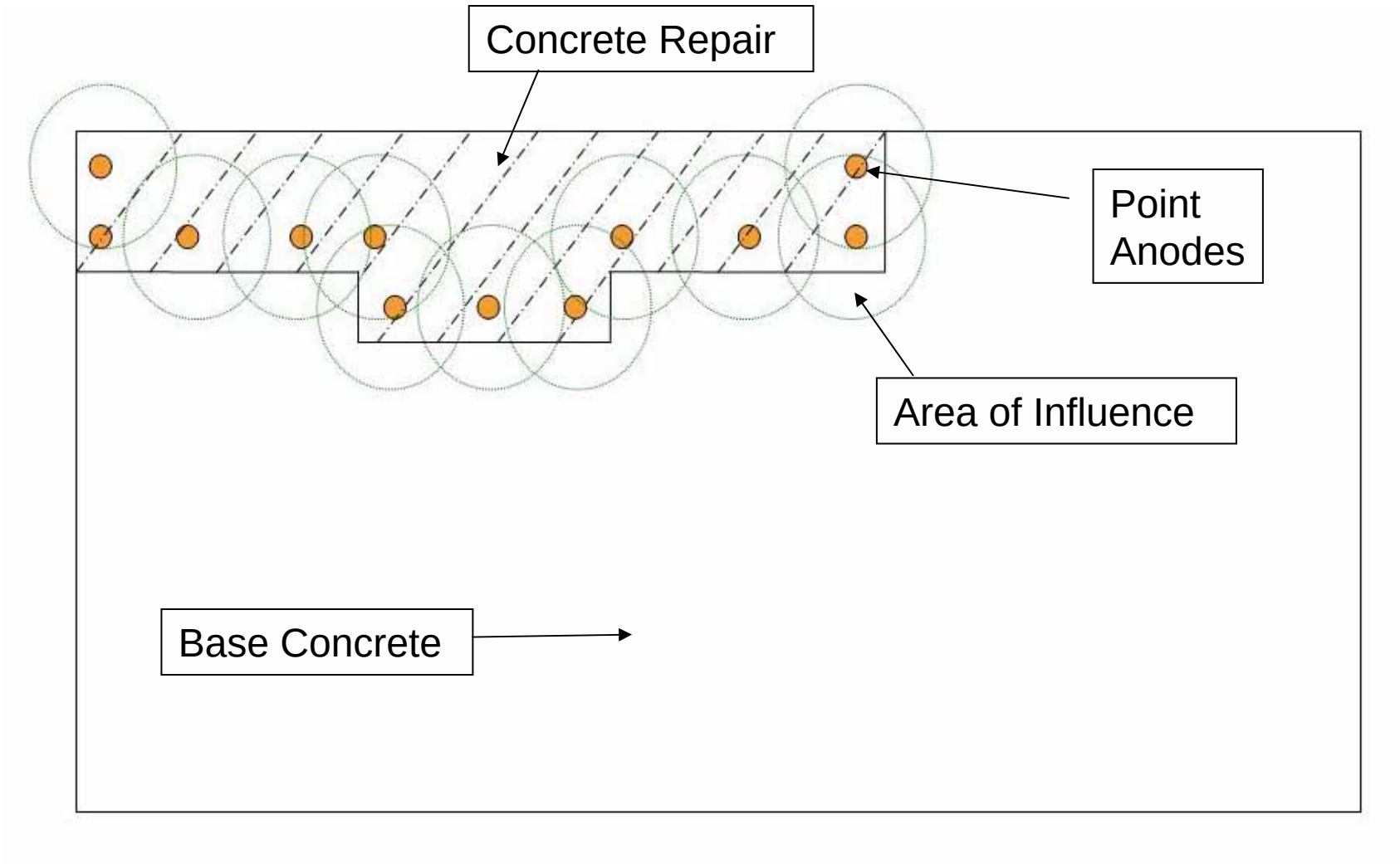
Alkali Activated

- High pH is corrosive to zinc but not to steel
- Allows zinc anodes to provide protection to reinforced concrete over time

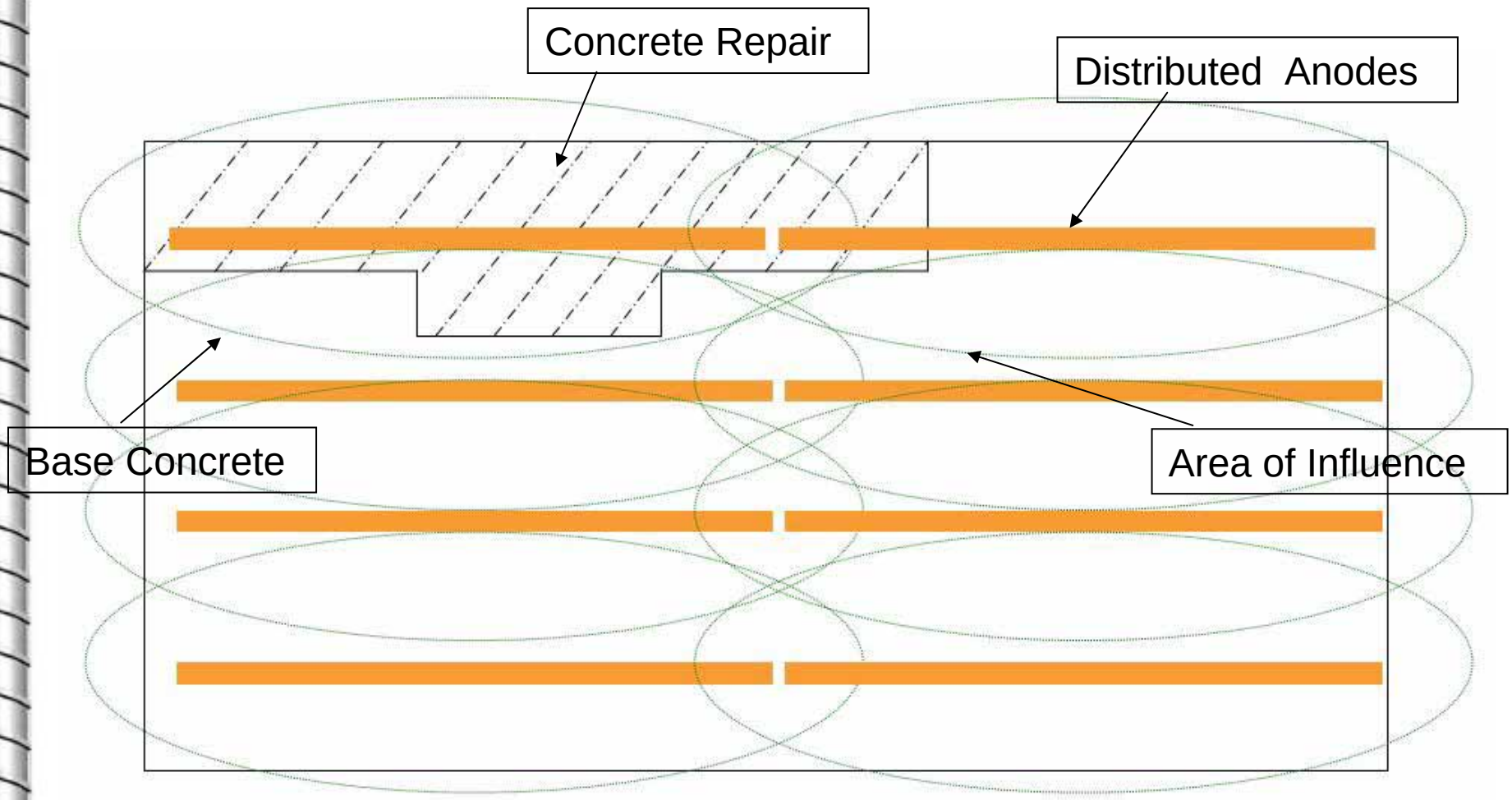


Point vs. Distributed Anodes

Point Anodes Protection



Distributed Anodes Protection



Kirkwood Road Bridge Before Repair
May, 2005


Abutment Condition Before Repair


Spall removal


Dowels and anodes installed

Anodes wired together and to reinforcing

Anodes wired for monitoring

Monitoring station


Ready for Forms


Forms installed


SCC Pumping Port

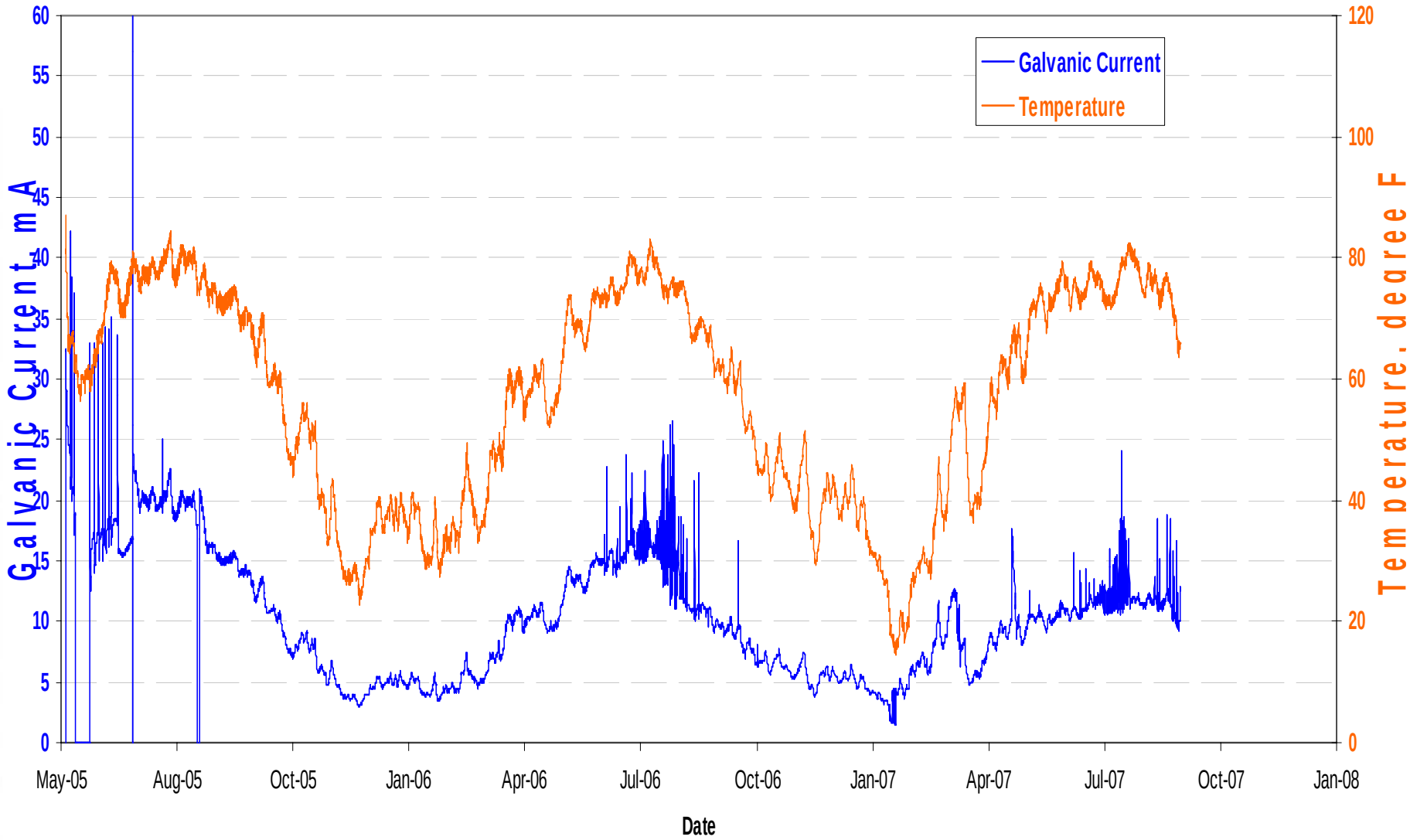

Forms removed


Completed repair

Galvanic Anode Monitoring

- Data logger installed in junction box
- Measurements taken every 4 hours
  - Anode Current Output
  - Internal and Ambient Temperatures
- Corrosion potentials and depolarization data collected on periodic site visits
  - Surface readings with copper-copper sulfate reference electrode
- Information used to determine level of protection and estimate anode service life

Kirkwood Road – Protective Current



Corrosion Mitigation for Reinforced Concrete Structures

Level of Protection	Objective	Typical Current Density Required
Corrosion Prevention	Prevent Initiation of Corrosion	0.25 to 2 mA/m2
Corrosion Control	Reduce Active Corrosion	1 to 7 mA/m2
Cathodic Protection	Stop Active Corrosion	2 to 20 mA/m2

Kirkwood Road Performance

Date	Temp	mA/m2	Polarization	Instant Off
5/6/05		37.7		654*
7/20/05		13.9	346	1000
8/16/05	87	12.9	333	987
10/26/05	54	5.4	394	1048
12/7/05	51	3.2	339	993
5/1/06	57	7.5	335	989
12/20/06	40	4.3	500	1154
5/30/07	79	7.5	446	1100
9/20/07	75	9.7	484	1138

* Native Potential

Cathodic Protection Criteria: Polarization > 100 mV or Inst. Off > 850 mV

Lessons Learned - Anodes

- Easy installation
  - approx. 5 min. each
- Minimal training required
- Temperature affects current output
- Anode system is meeting NACE cathodic protection criteria
- Theoretical anode life = 21.8 years
  - Based on current output data from monitoring

Other Distributed Anode System Applications

I-75 in Auglaize County, 2006

Galvanic Strips In 8 Bridge Deck Overlays Lake County, OH

Bridge Column Repair with Reinforced Concrete Jacket

Bridge Pier Cap Repair with Galvanic Anode Strips

Acknowledgements

- The authors would like to thank Matt Miltenberger, PE of Tourney Consulting for anode monitoring, performance and service life assessment