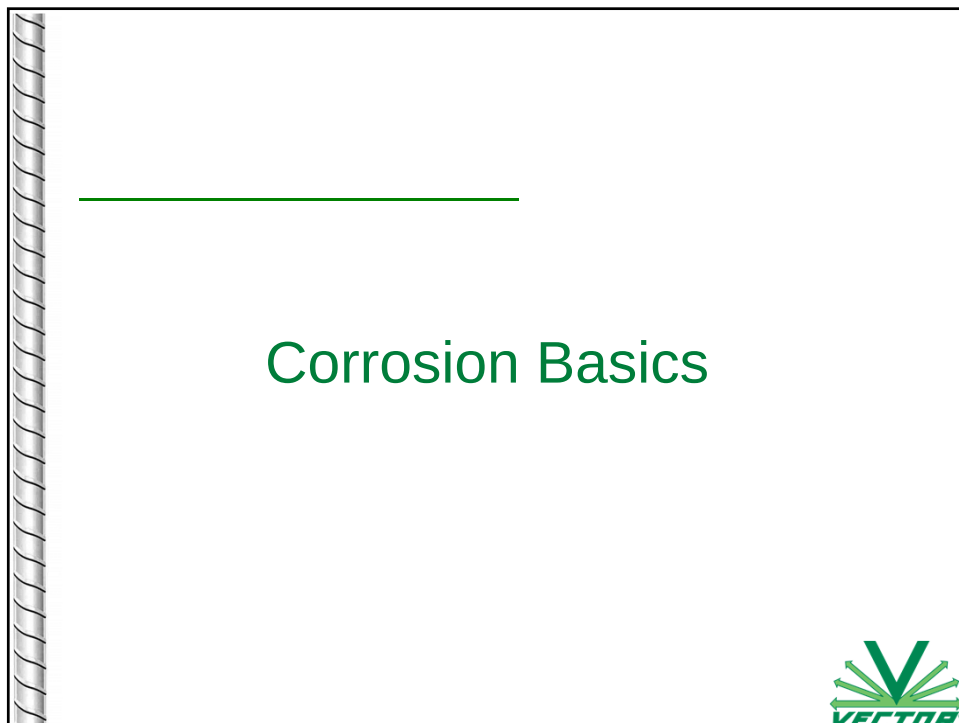






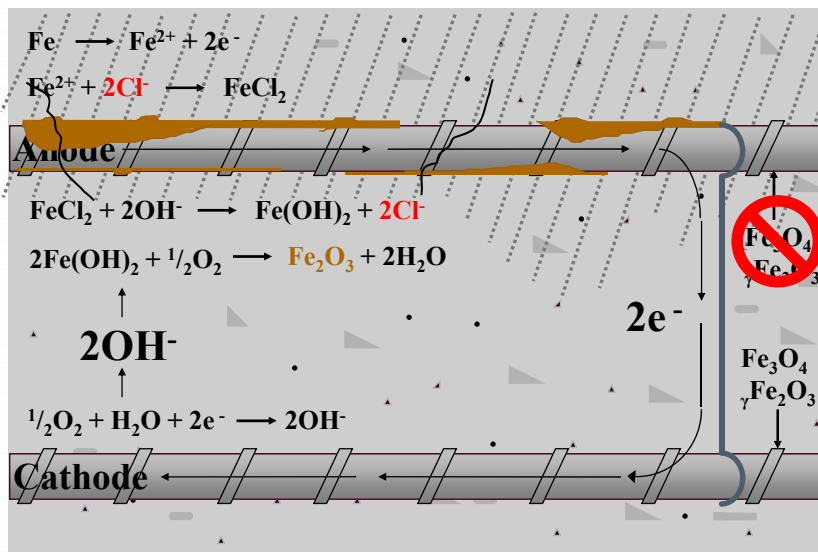
Causes of Corrosion

- Chlorides
- Carbonation
- Dissimilar Metals

Results in the Destruction of the Steel's Passive Oxide Layer



Corrosion Cell in Concrete

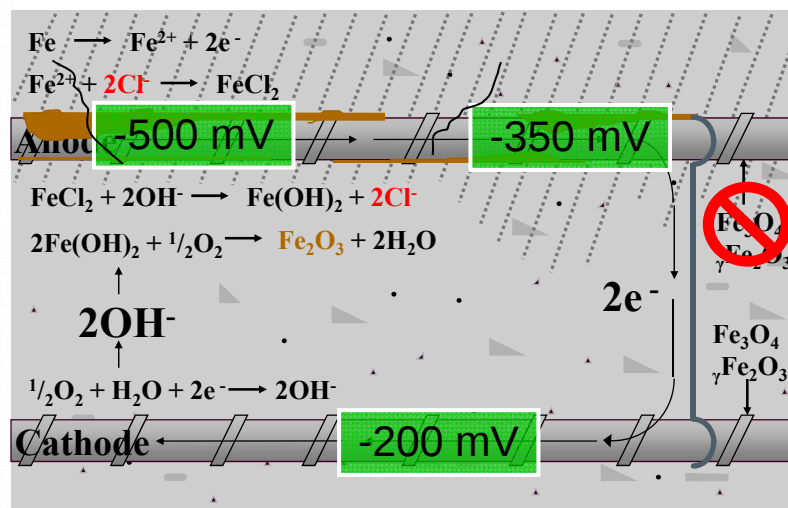


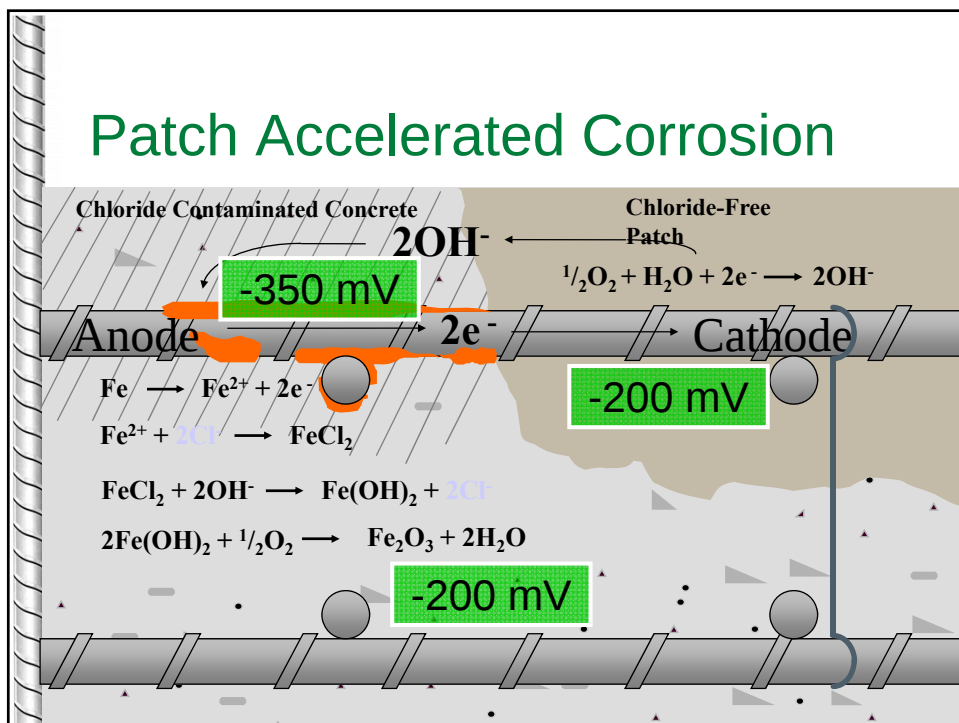
Why Does This Occur?

Corrosion Potential for Steel in Concrete	
<u>Metal</u>	<u>Voltage</u>
Steel in Chloride-Free Concrete	0 to -200 mV
Steel in Chloride-Contaminated Concrete	-350 to -500 mV
*Typical potentials measured with respect to copper-copper sulfate electrode	



Corrosion Cell in Concrete







Halo Effect



Galvanic Corrosion Protection Systems

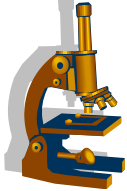


Galvanic Protection Systems

- 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

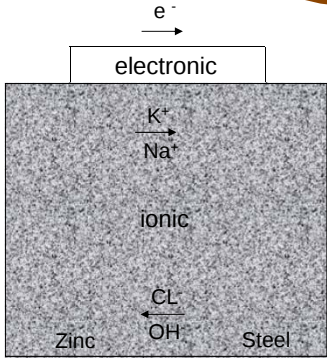


Galvanic Protection



Partial Galvanic Series	
<u>Metal</u>	<u>Voltage</u>
Zinc	-1100 mV
Steel in concrete	-200 mV to -500 mV

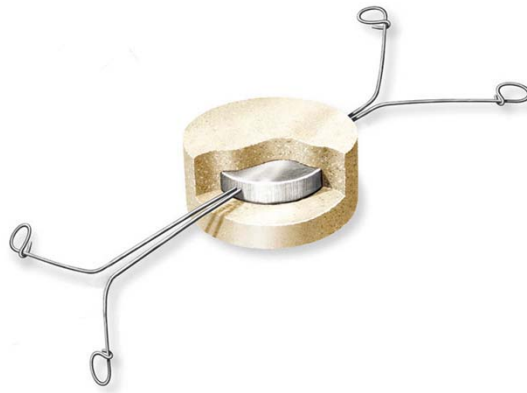
*Typical potentials measured with respect to copper-copper sulfate electrode



Galvanic anodes naturally operate based on the principle of dissimilar metals corrosion like commonly used batteries. Current flows from the anode (the metal with the most negative potential) to the cathode (steel).



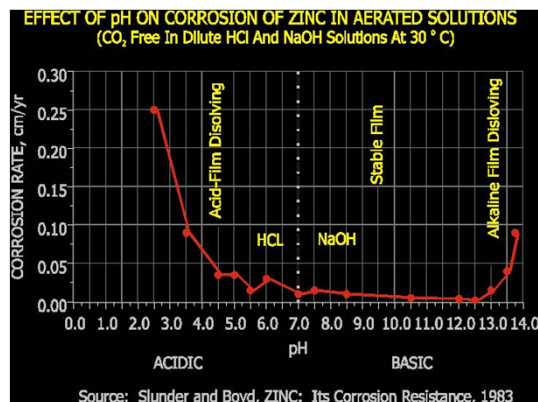
Embedded Galvanic Anodes for Corrosion Prevention

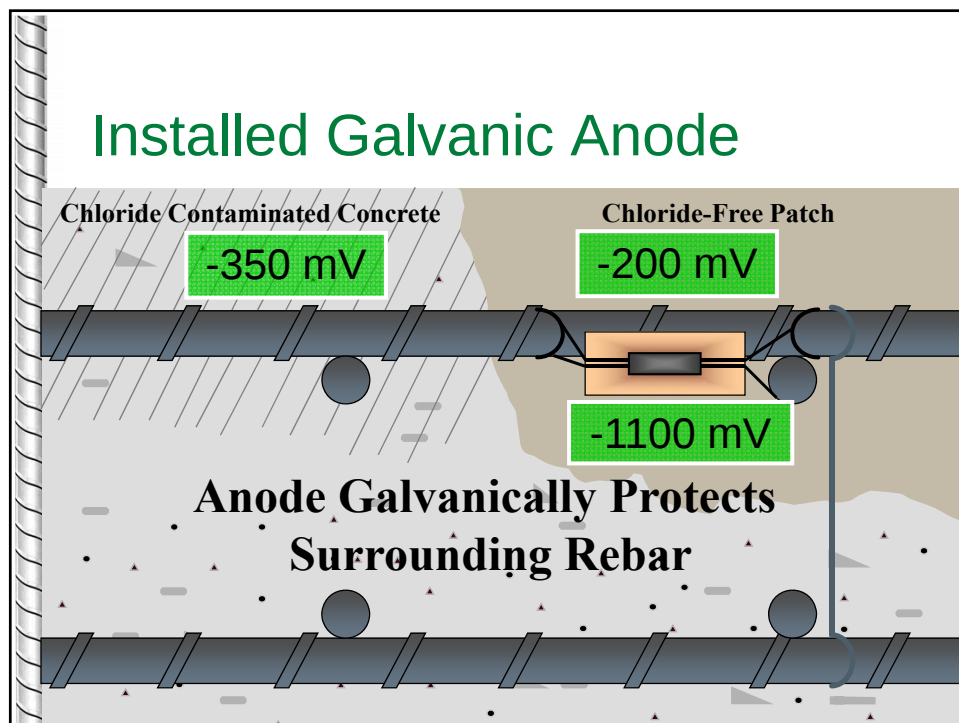
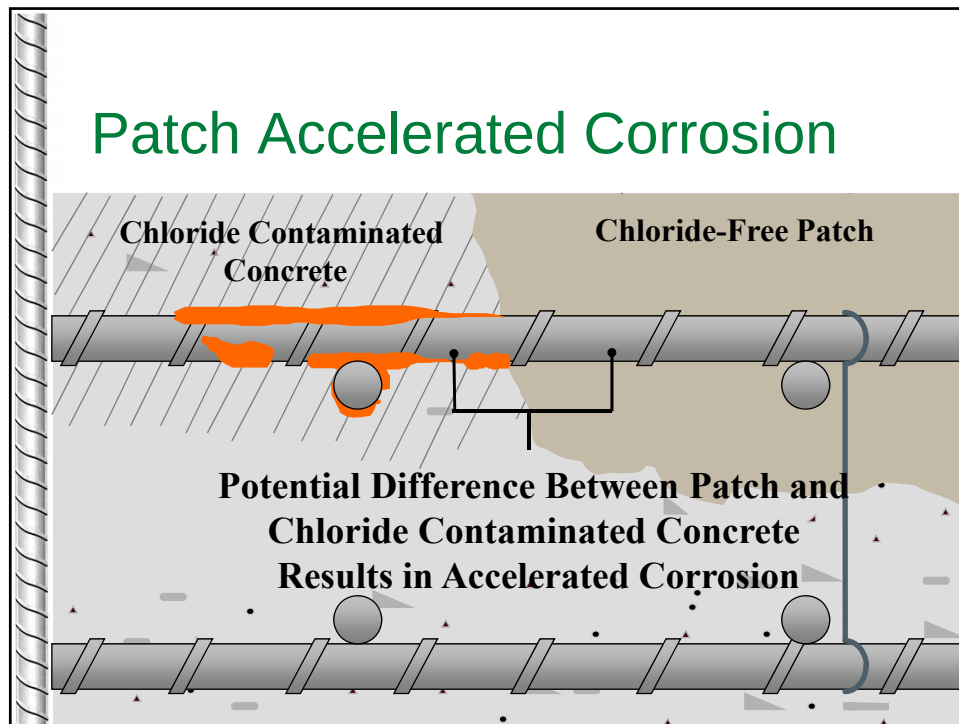


Activation Technology

Alkali Activated

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





Anode Installation



Installing anodes around the perimeter of the repair



Quick and Easy Installation

Anode Installation



Testing anode connection to reinforcing steel.

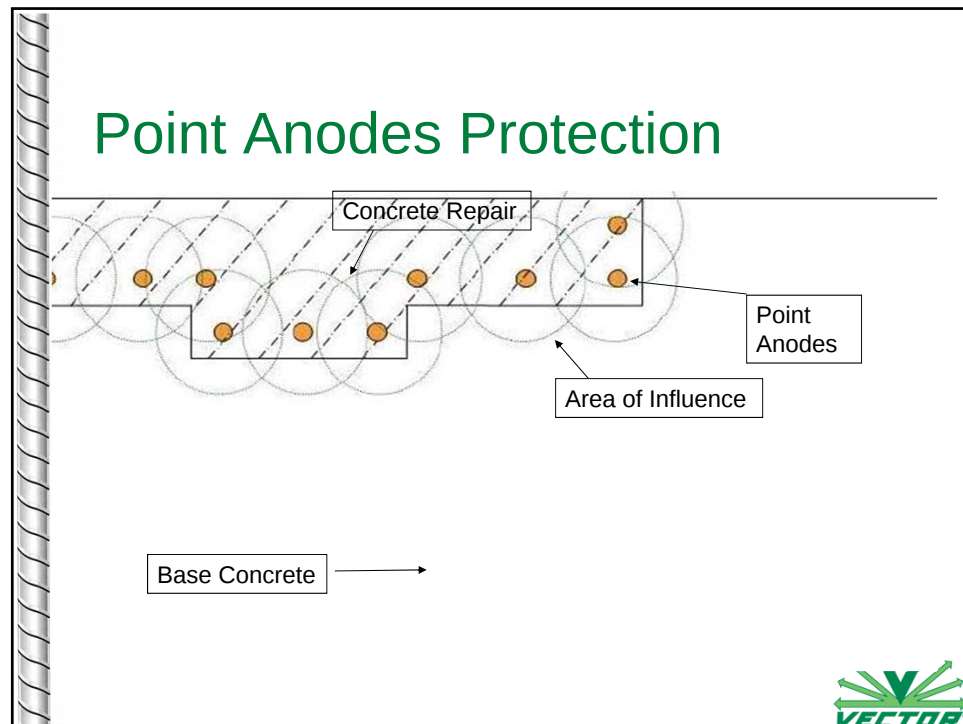


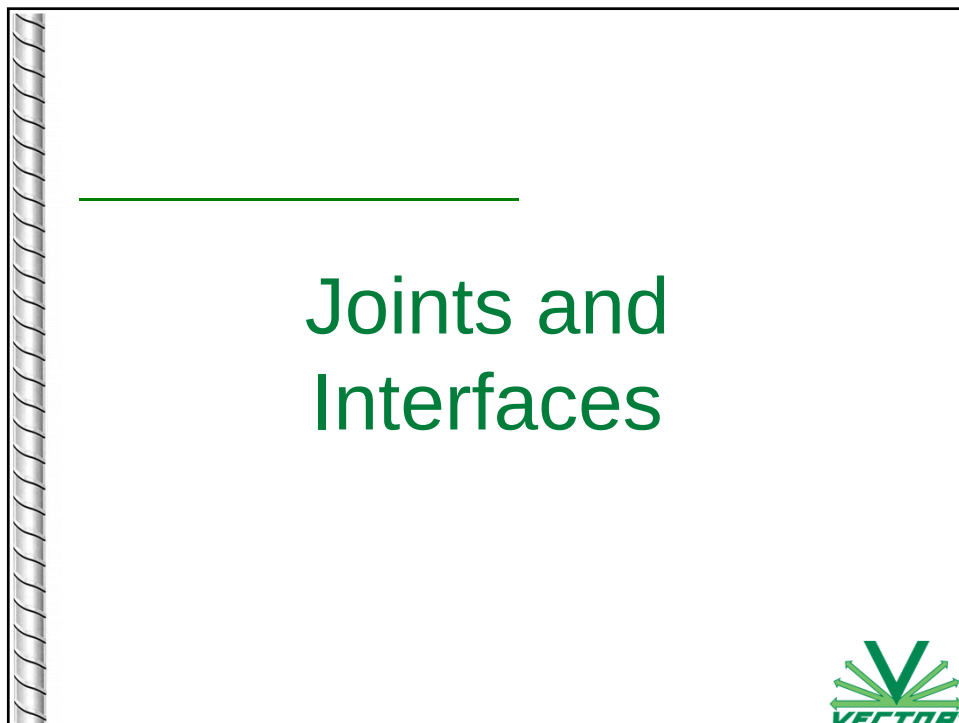
Anode Installation

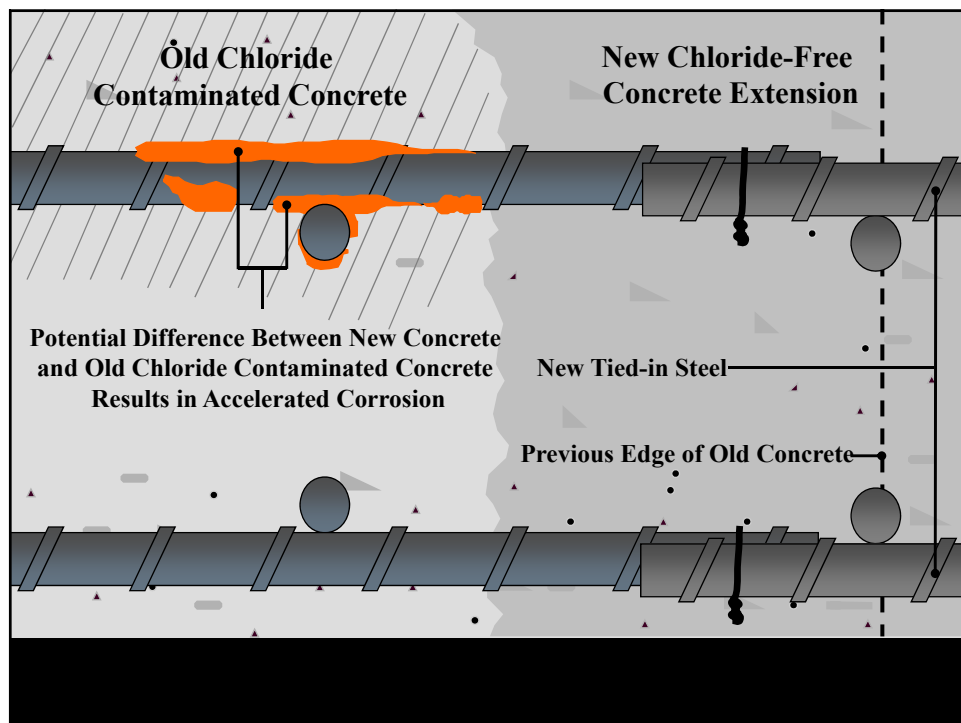
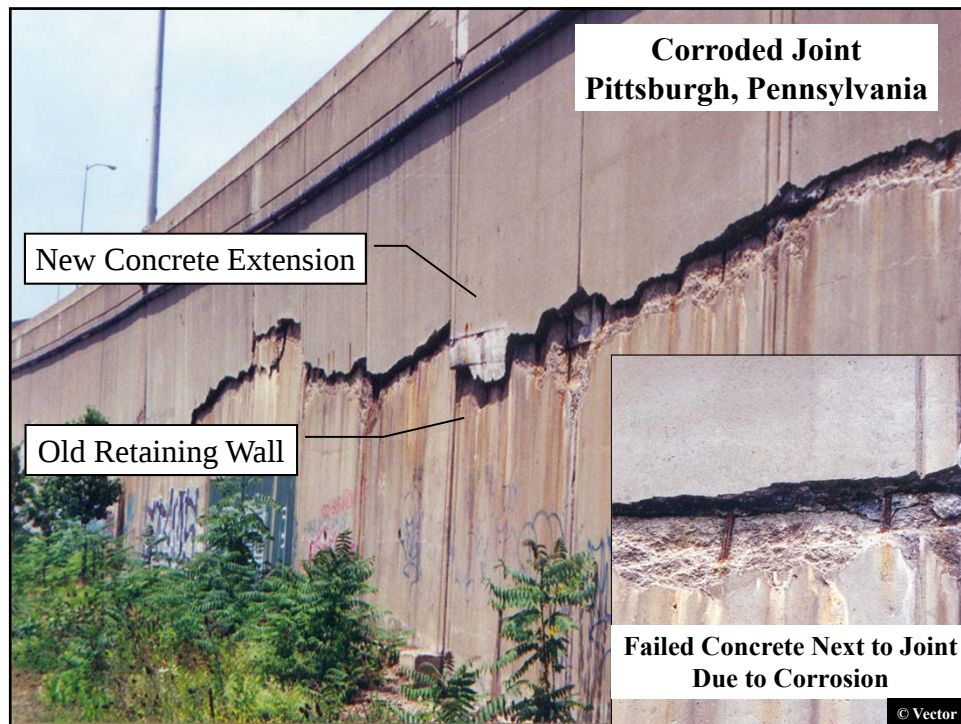


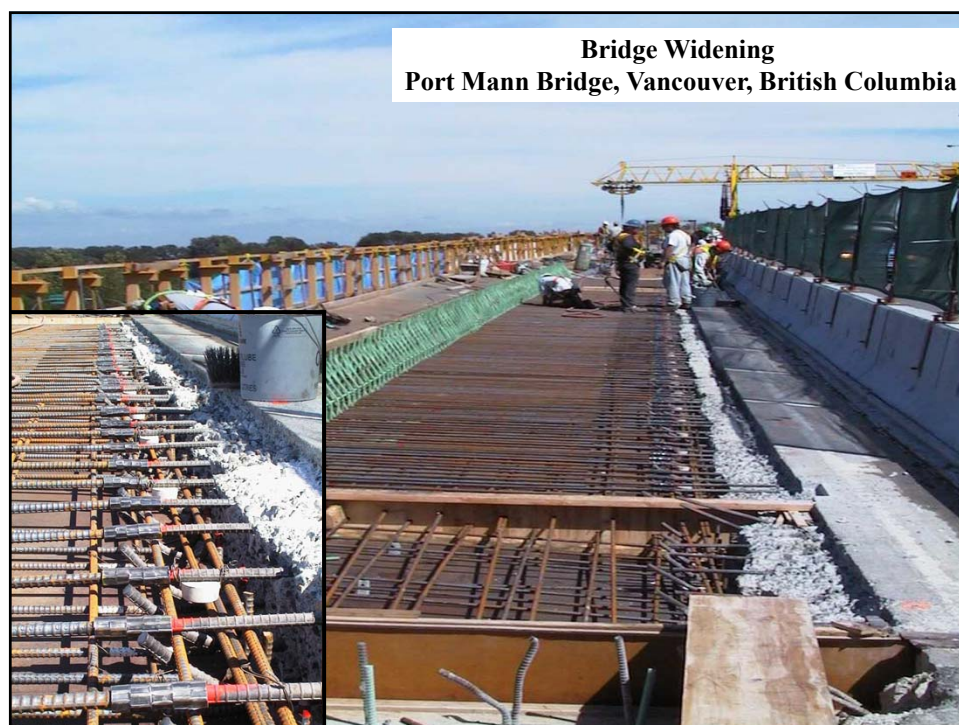
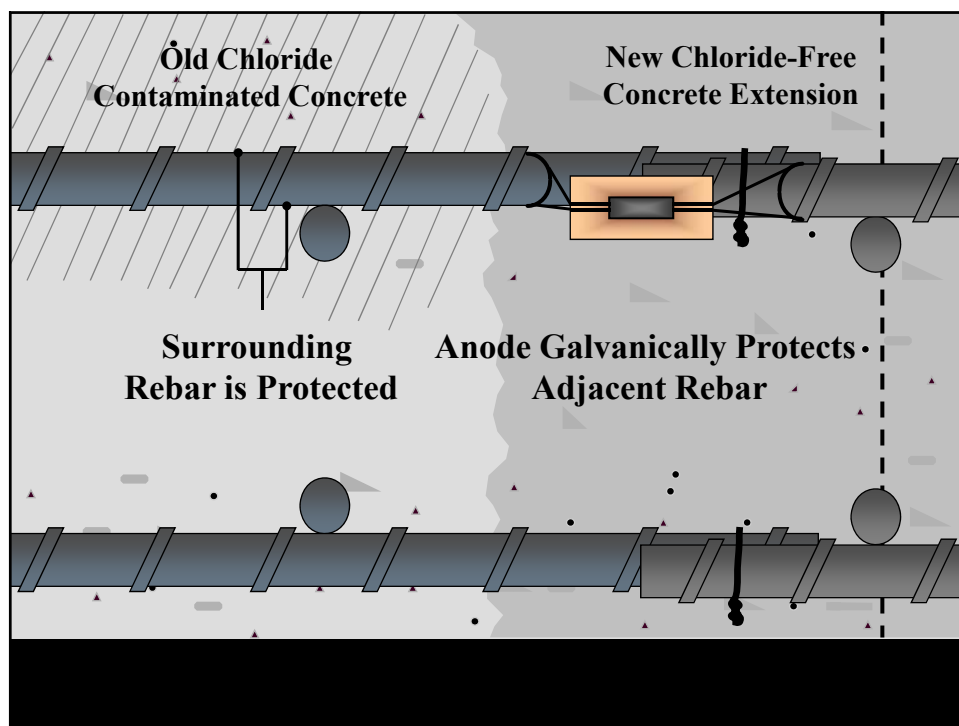
Embedding anodes with repair material.

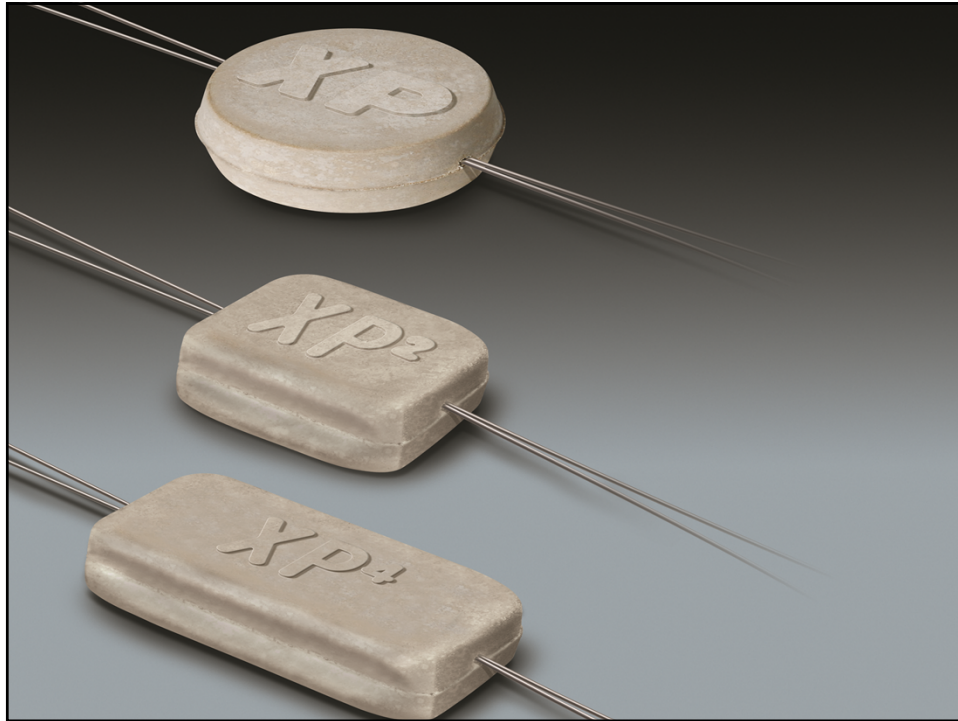












Embedded Galvanic Anodes - Nomenclature

Type 1

–Installed in Standard Repairs

Type 2

–Installed in Sound Concrete



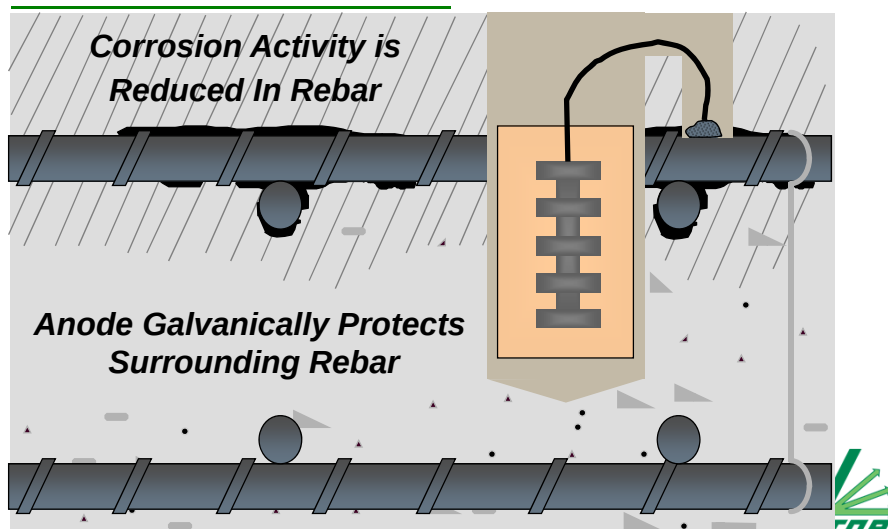
Source: Installation of Embedded Galvanic Anodes (ACI RAP Bulletin 8, 2010)

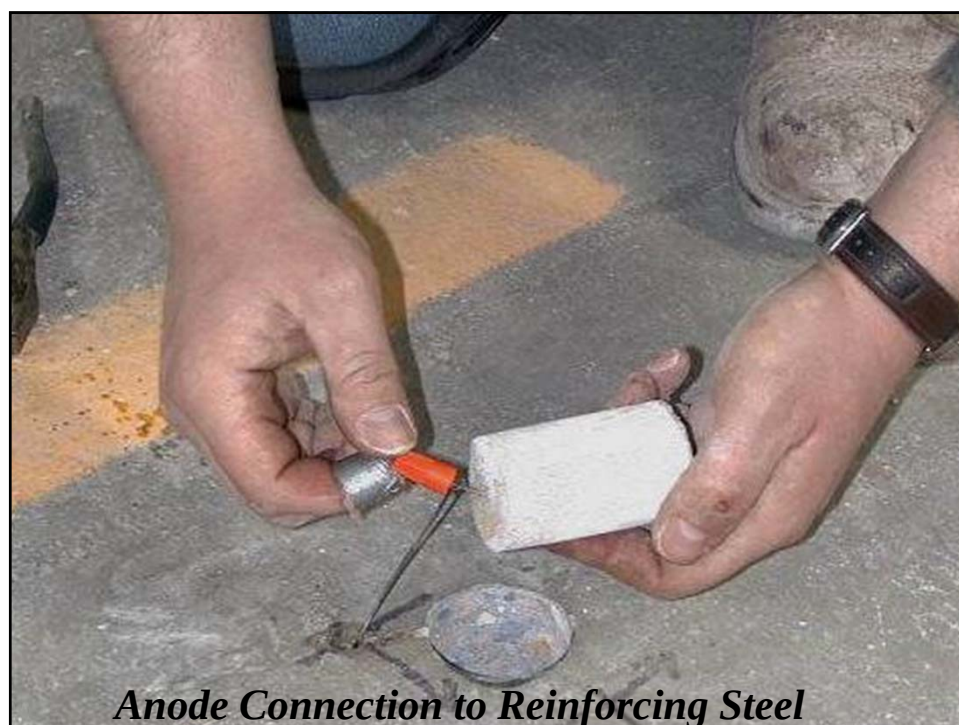
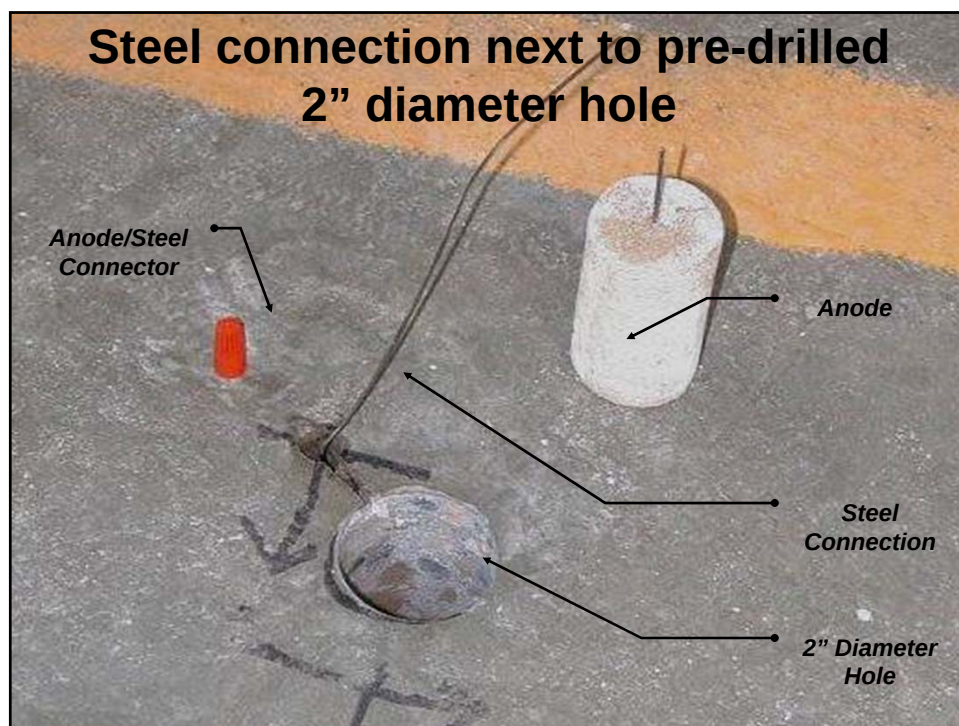


Drilled in Discrete Anodes



Corrosion Control Anode Installation





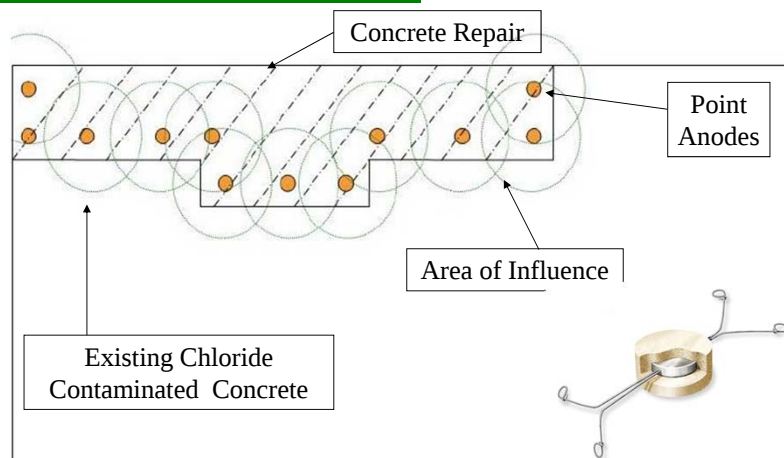


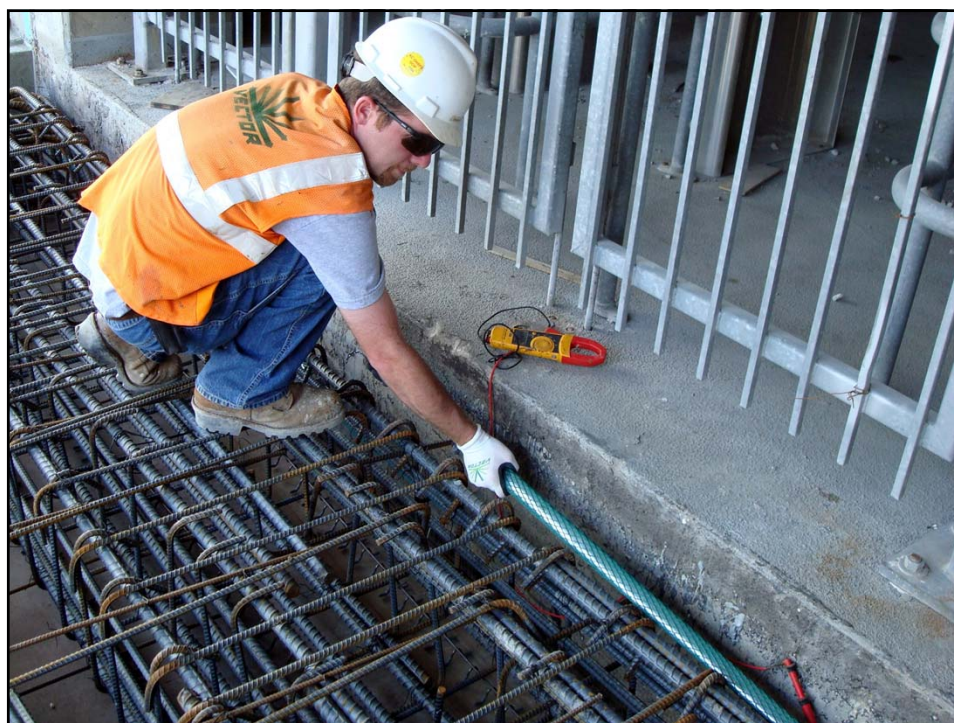
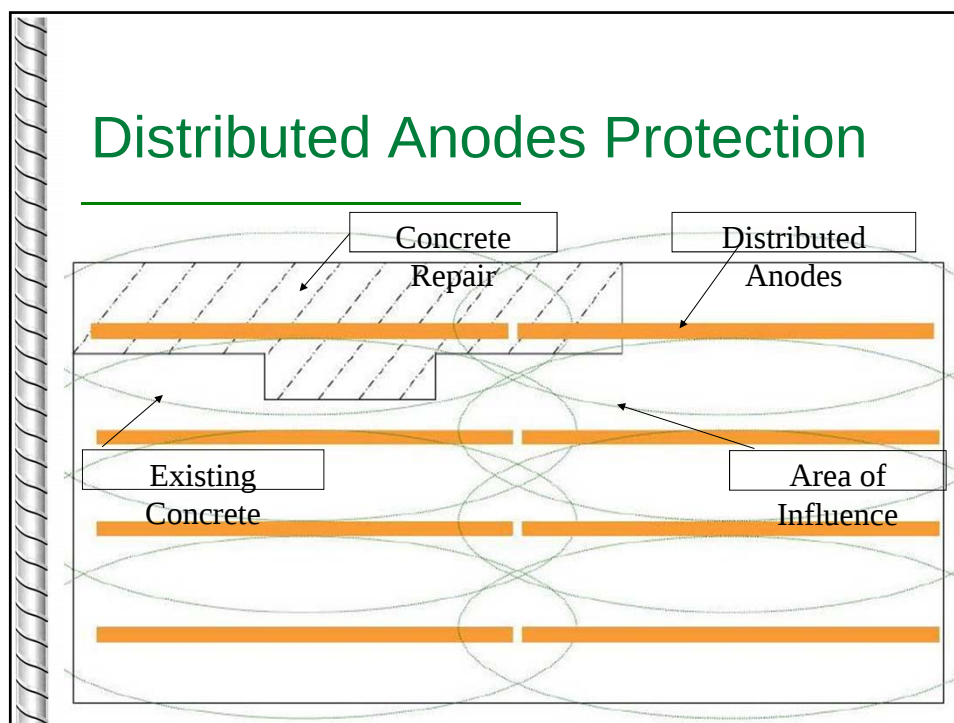
**Predrilled Holes for CC Installation
Parking Garage Deck**

Point Anodes vs. Distributed Anodes



Point Anodes Protection



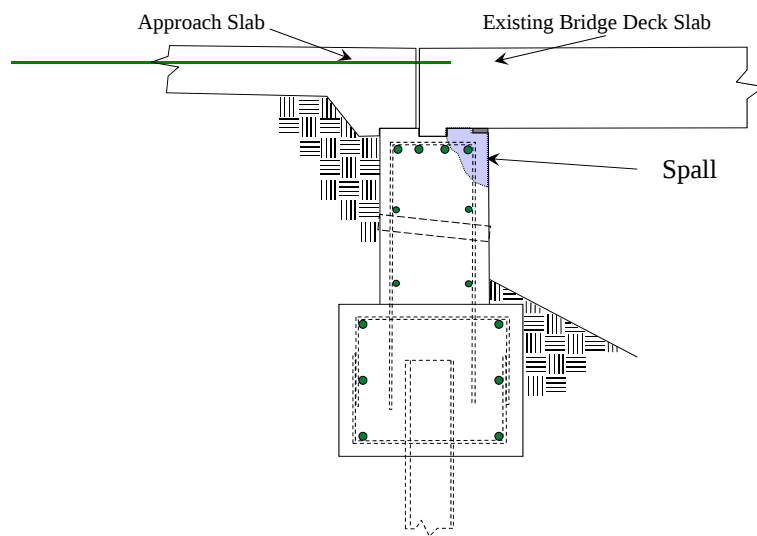


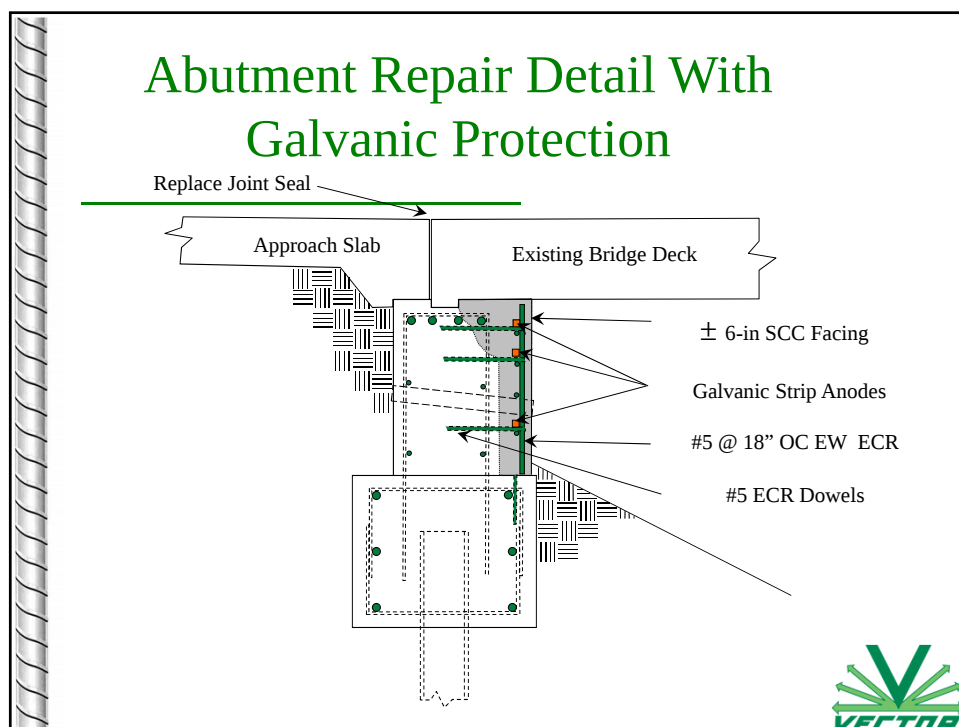
On Many Slab Bridges...

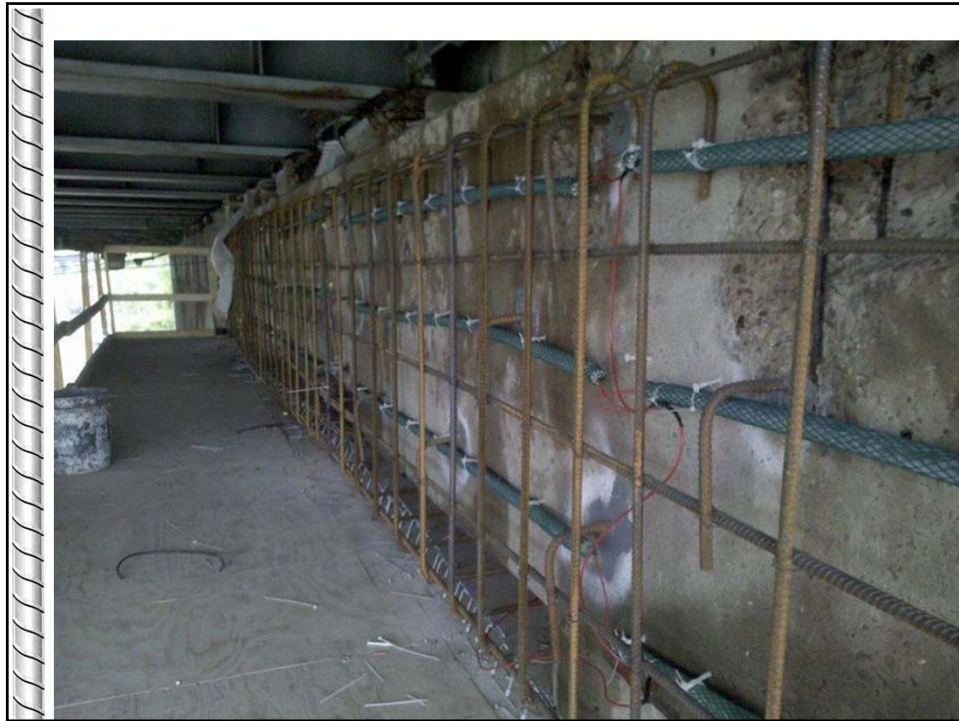
- Slabs are in good condition
- Deterioration at abutment around the key way



Typical Slab Bridge Abutment

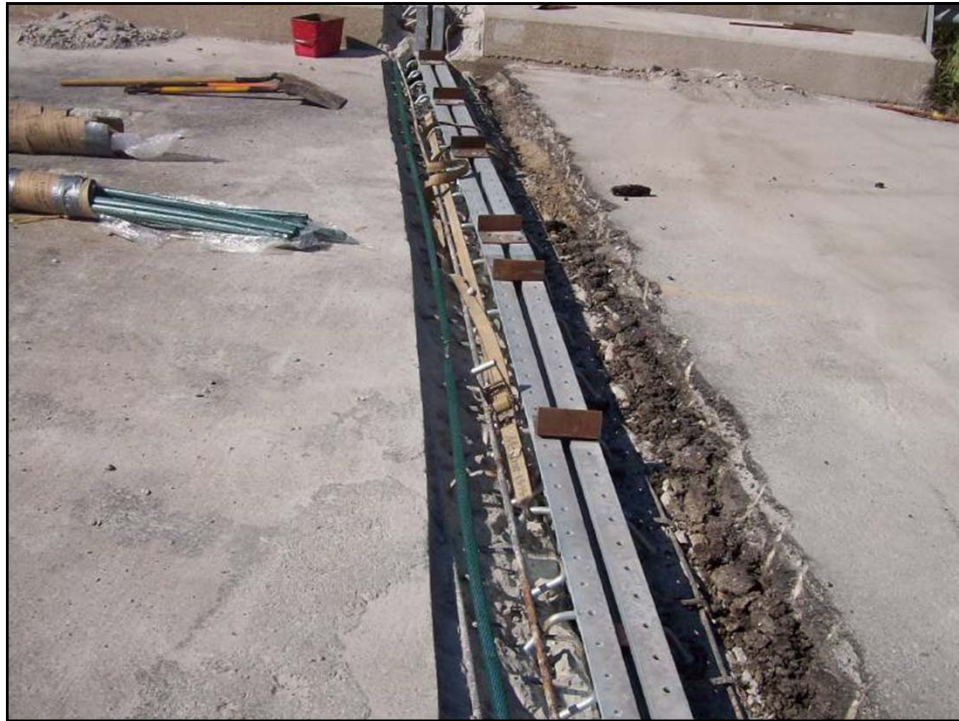




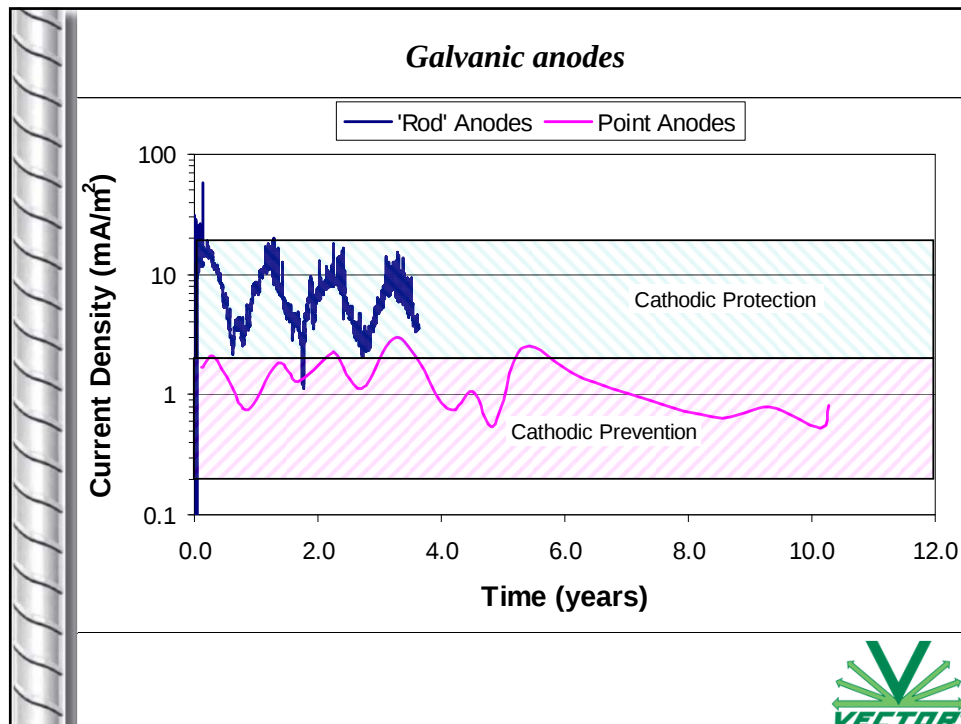


Galvanic Anodes Bridge Deck Overlays

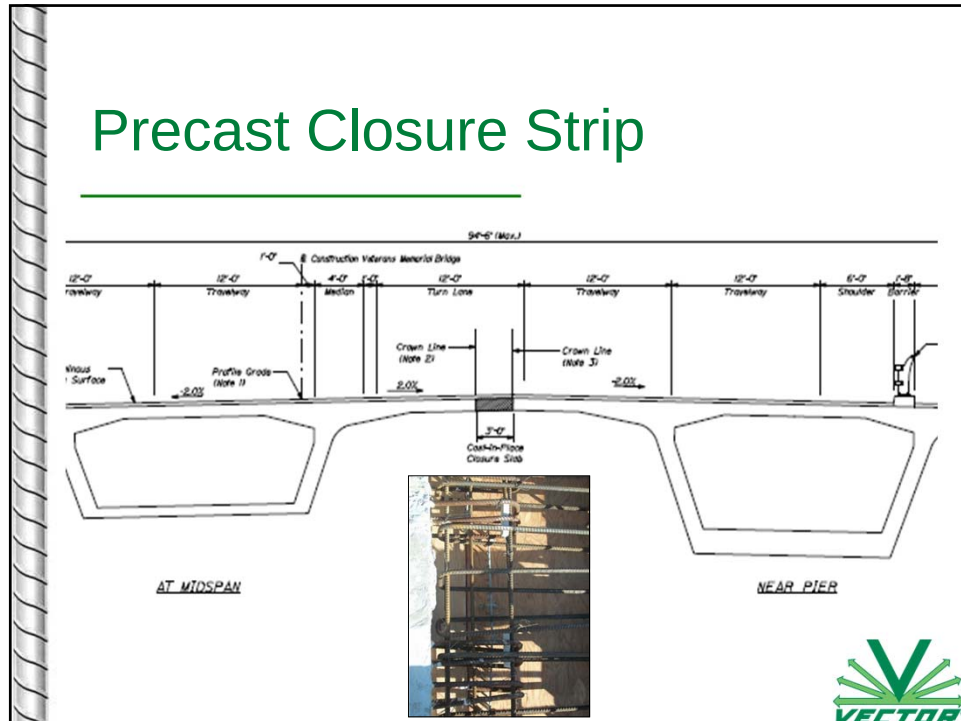




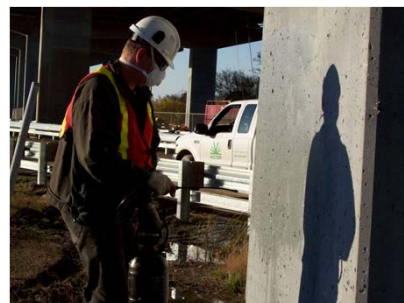




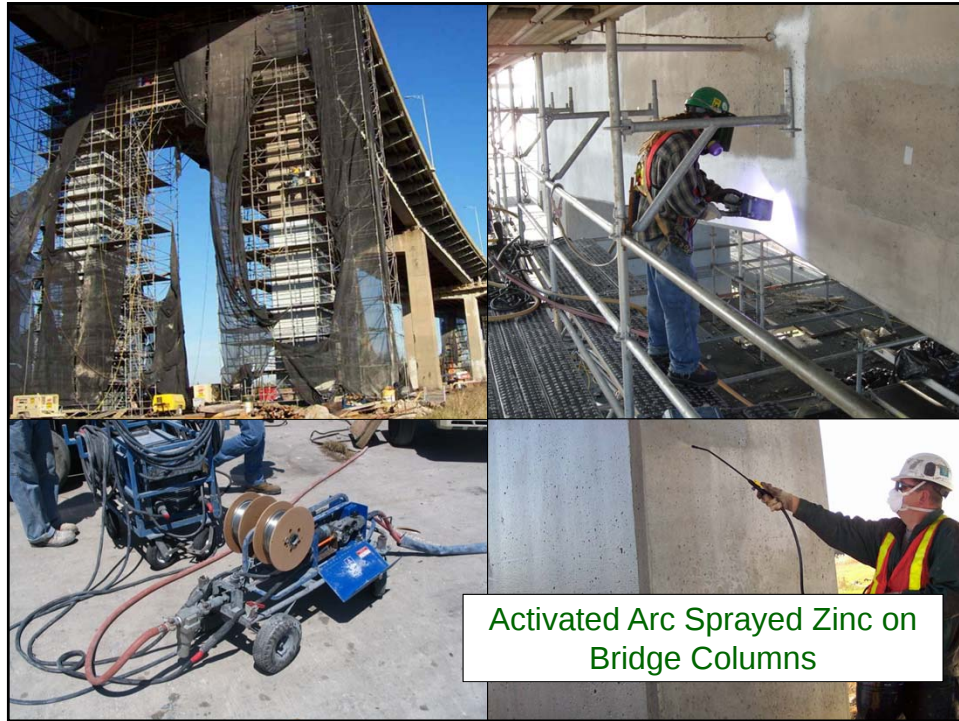
Precast Closure Strip



Galvanode ASZ+ Activated Arc Spray Zinc







Electrochemical Treatments

- Chloride Extraction (ECE)
- Re-alkalization
- *Lithium Impregnation (ASR Treatment)

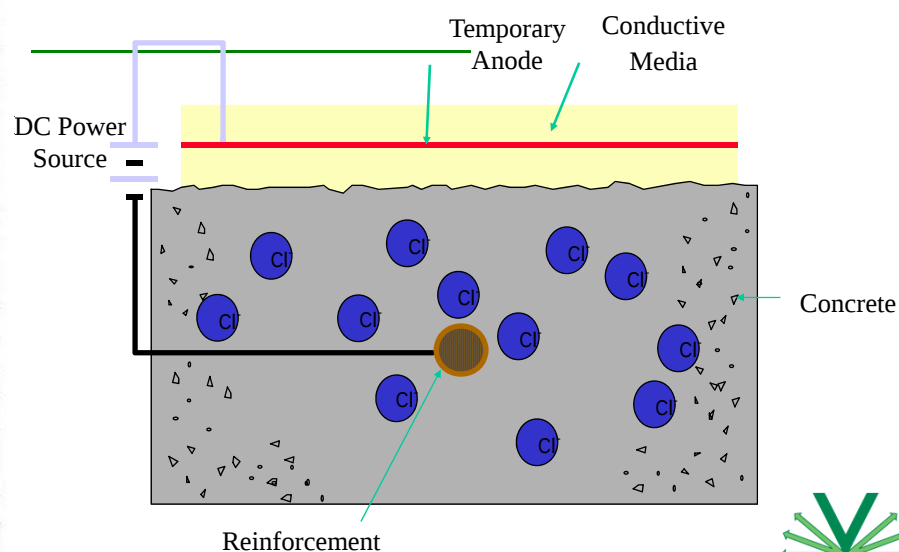


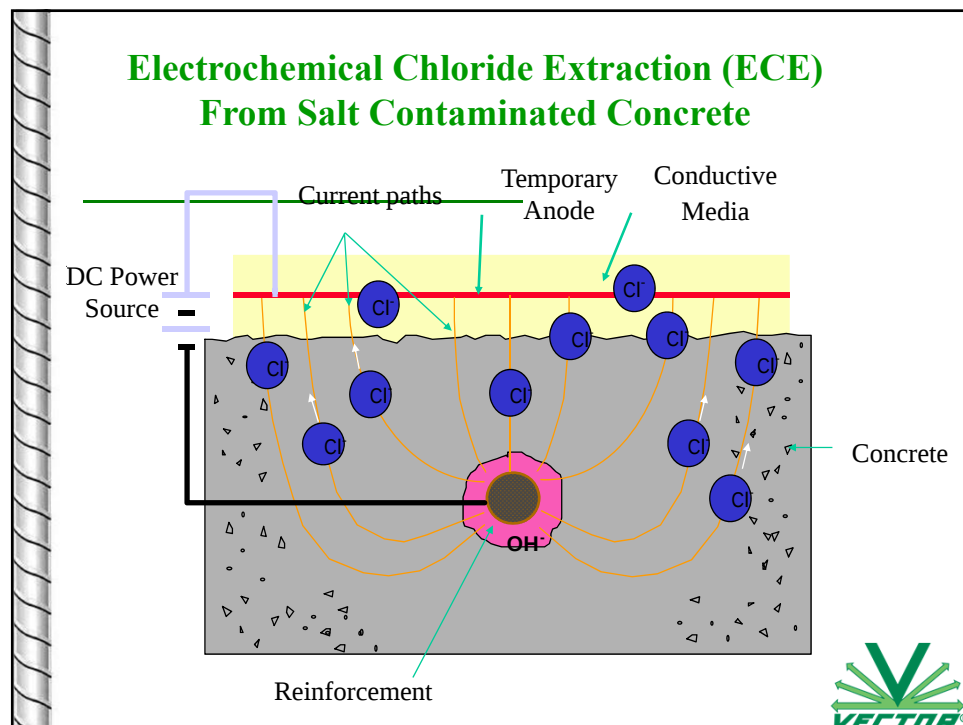
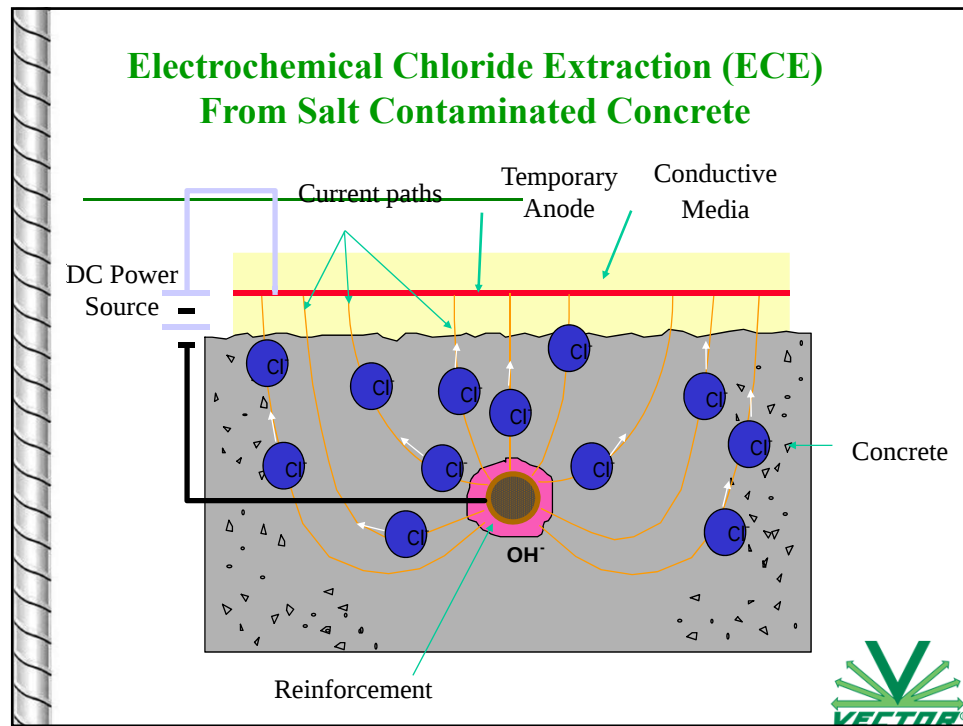
Electrochemical Chloride Extraction

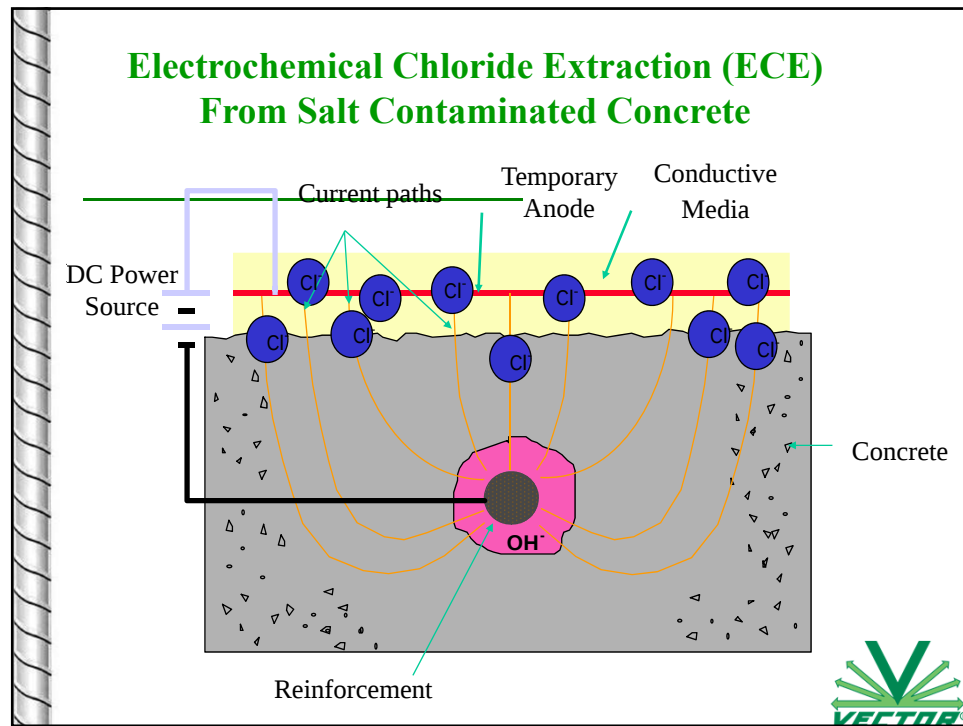
- Temporary electrical treatment applied to passivate active corrosion by reducing chloride and increasing pH around the reinforcing steel.

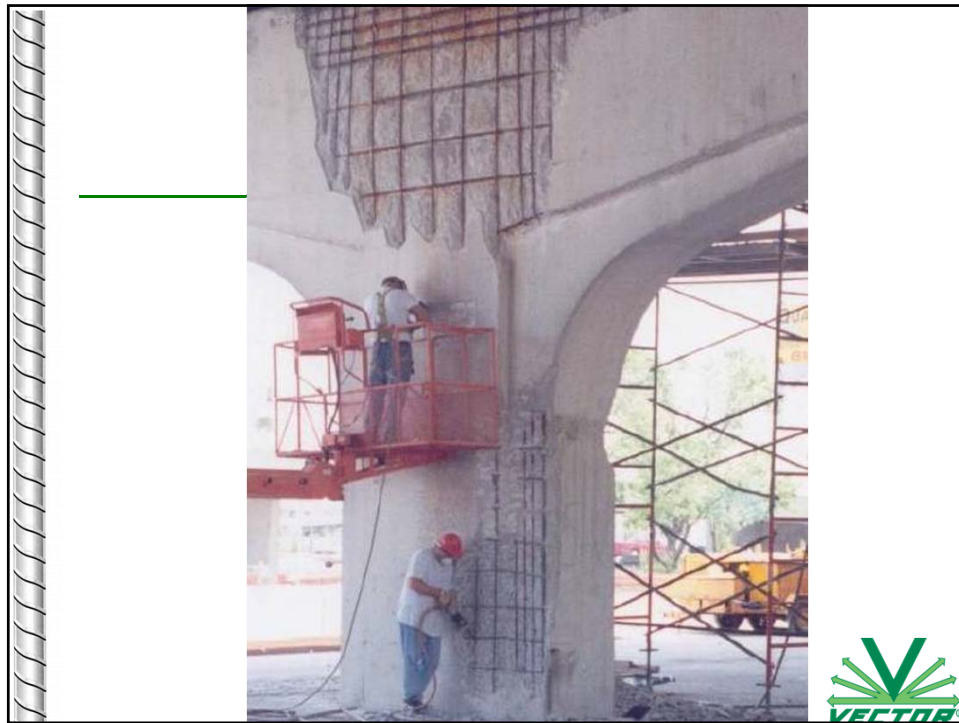


Electrochemical Chloride Extraction (ECE) From Salt Contaminated Concrete







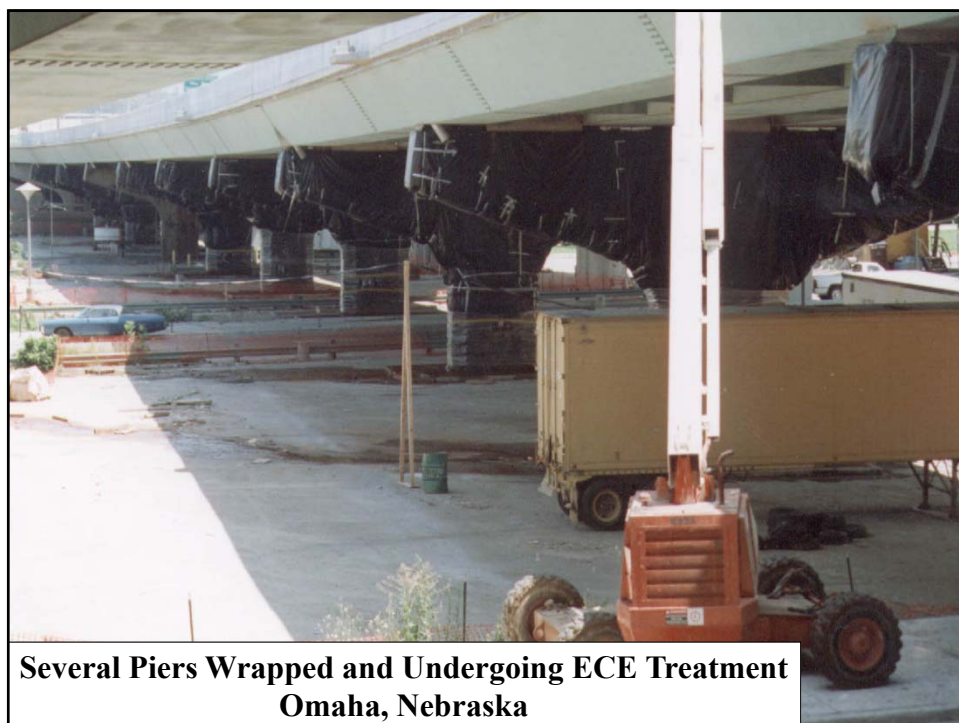


Norcure[®] ECE Treatment Process





Cellulose Fiber Serves as Electrolyte



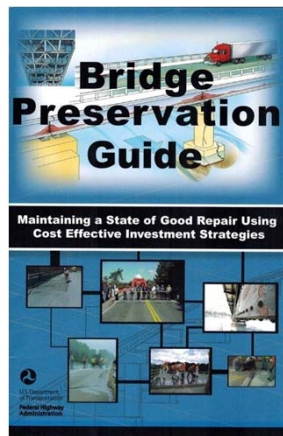


Rainbow Bridge- Idaho





FHWA Bridge Preservation Guide



FHWA-HIF-11042, August, 2011

- In US, 25% of 600,000 bridges are Structurally Deficient or Functionally Obsolete
- 30% of bridges have exceeded their 50 year design life
 - Need repair, rehabilitation or replacement
- A need exists to develop adopt and implement systematic process for bridge preservation
- Since 2008, Systematic Preventive Maintenance (SPM) is eligible activity under the Highway Bridge Program





Questions



Do we have a few more minutes?

