Testing for Stray Current Corrosion in Earth Covered Magazines with EOP

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Report Documentation Page

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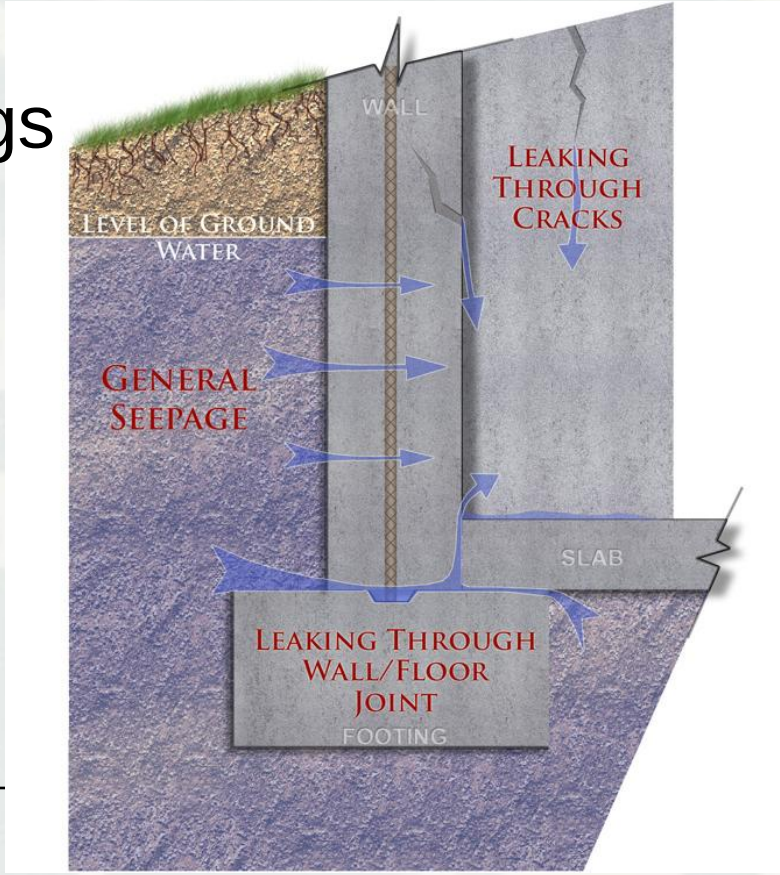
Outline

- EOP Technology
- Stray Current
- Stray Current Testing
- Test Findings
- Recommended Test Procedures
- Conclusion

Background

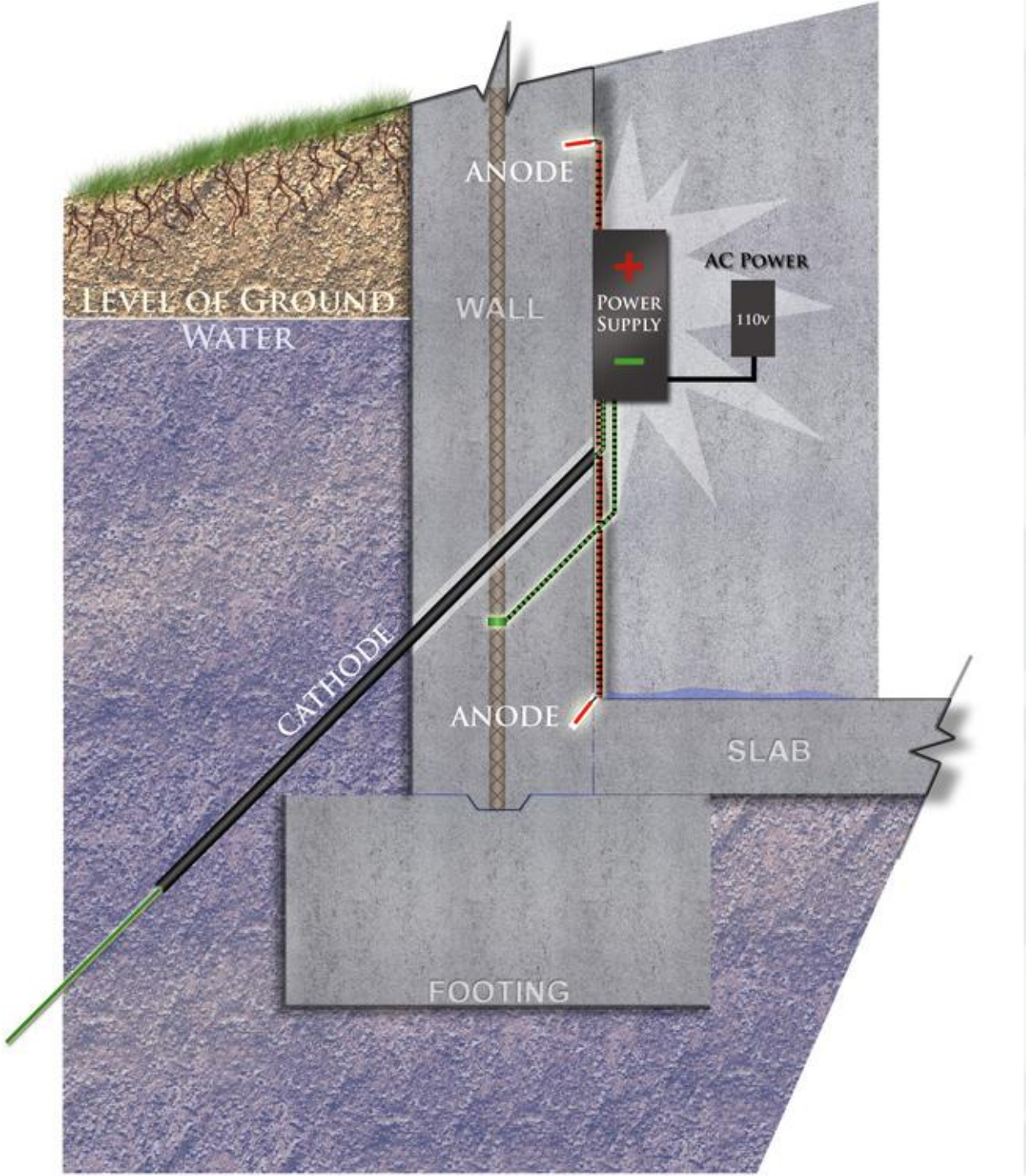
- Underground Structures inherently have moisture intrusion problems
- Large volumes of water seep through the concrete
  - Walls, floors, and ceilings
    - Rising damp
    - Wicking
    - High external head
  - Joints and cracks



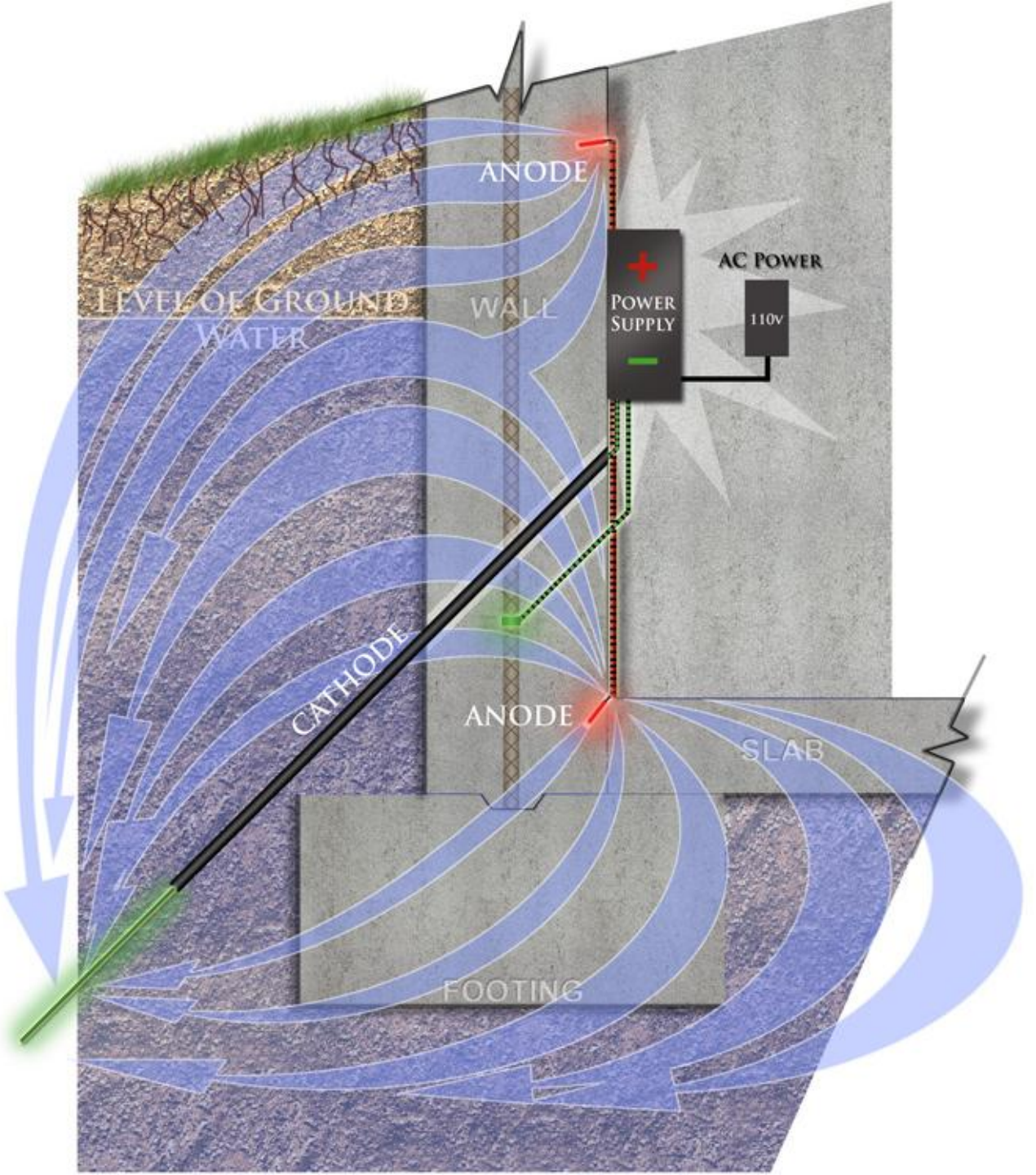
Background

- The water intrusion causes corrosion
  - Structural steel
  - Stored assets making many unusable
  - Mold and poor air quality

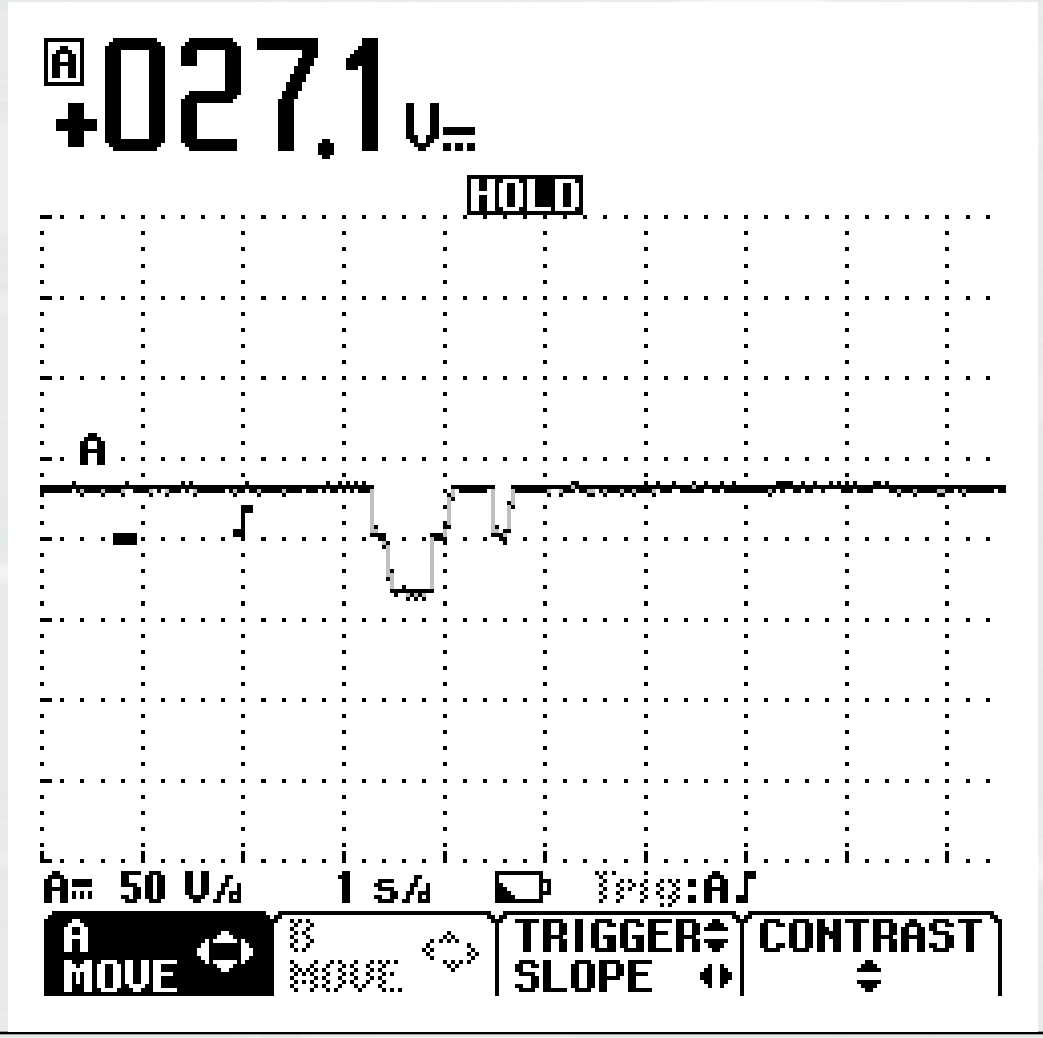
Typical EOP Installation



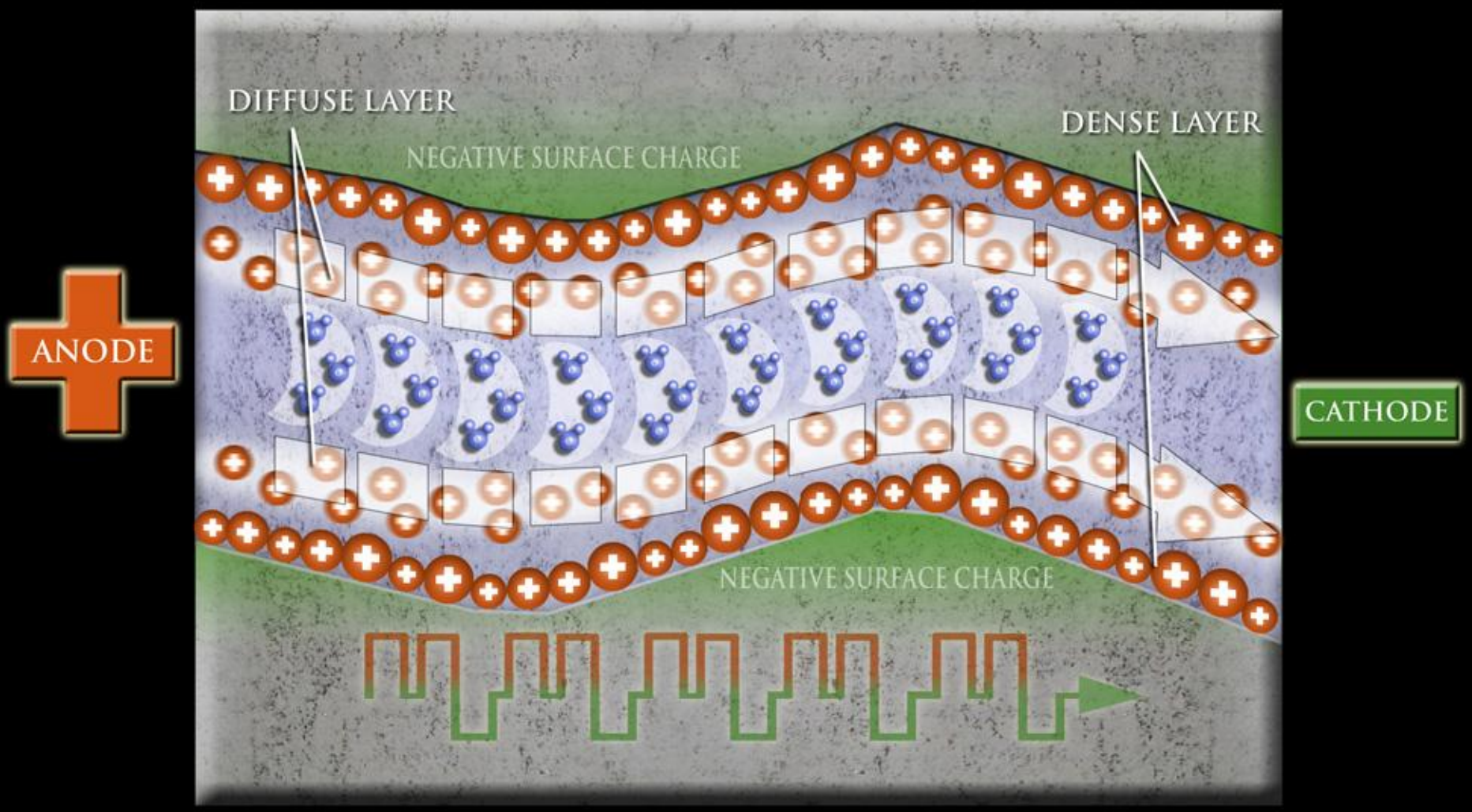
When activated EOP sets up an electric field that creates an osmotic force within the concrete pores that counters head forces



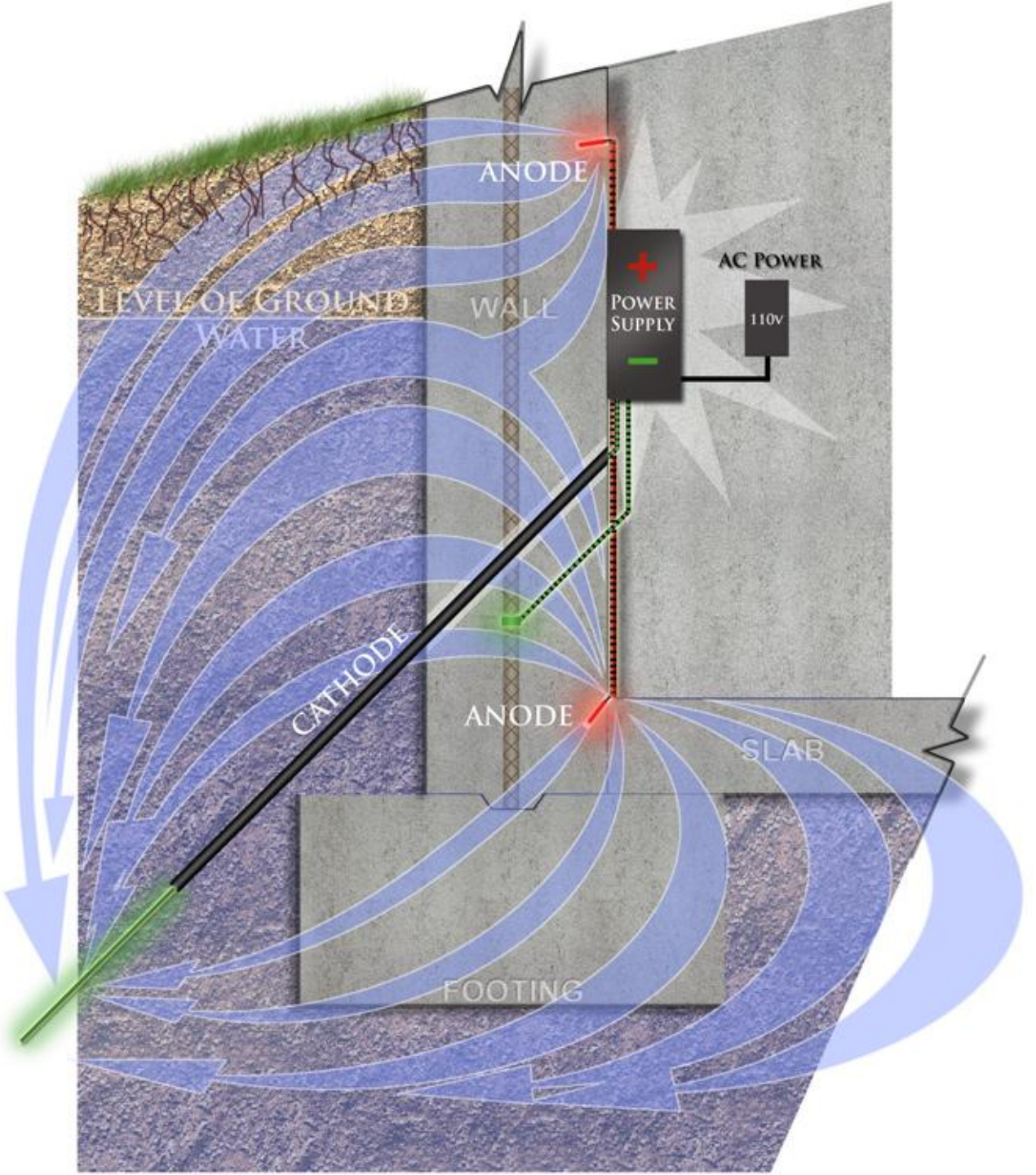
Typical EOP Pulse



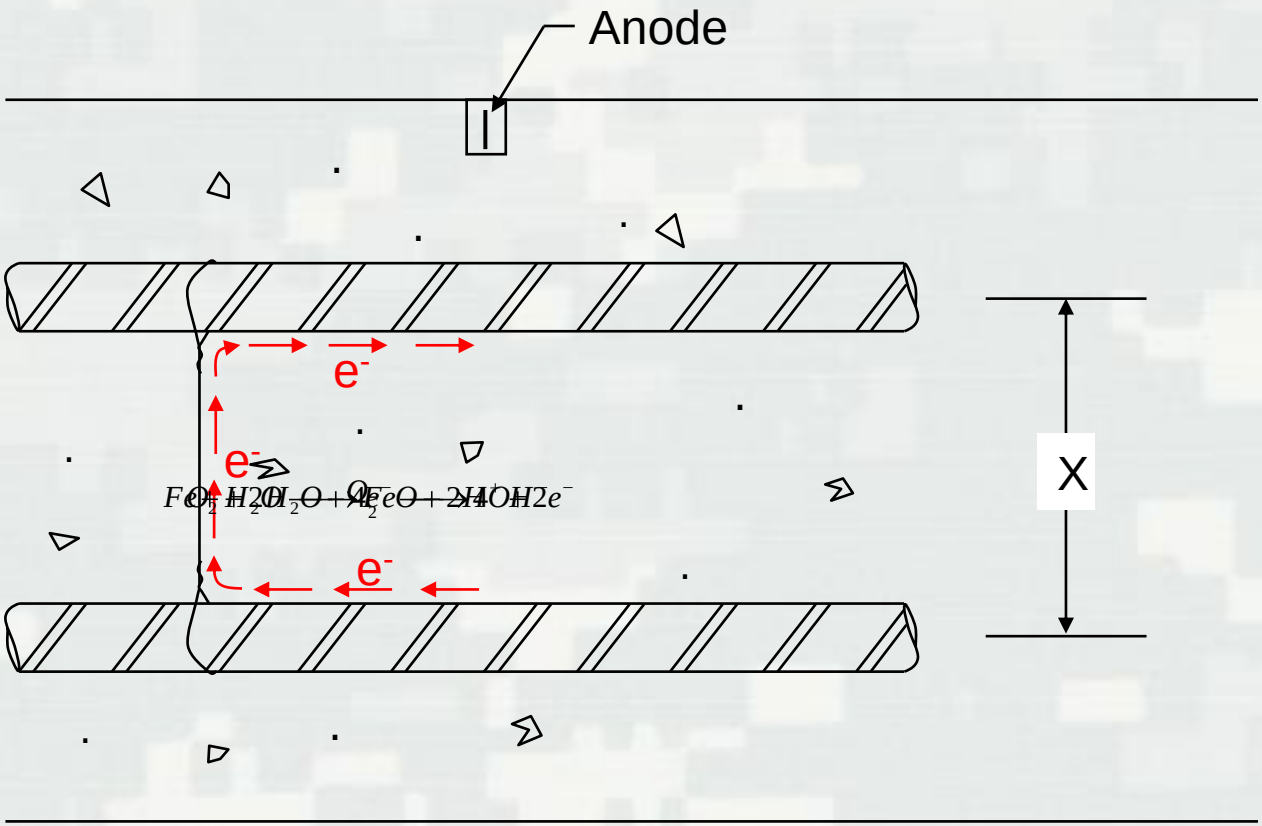
EOP Pulse Effect



DC current has potential for causing corrosion of metallic objects between anode and cathode



Stray Current



Cathodic Reaction

$$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$$

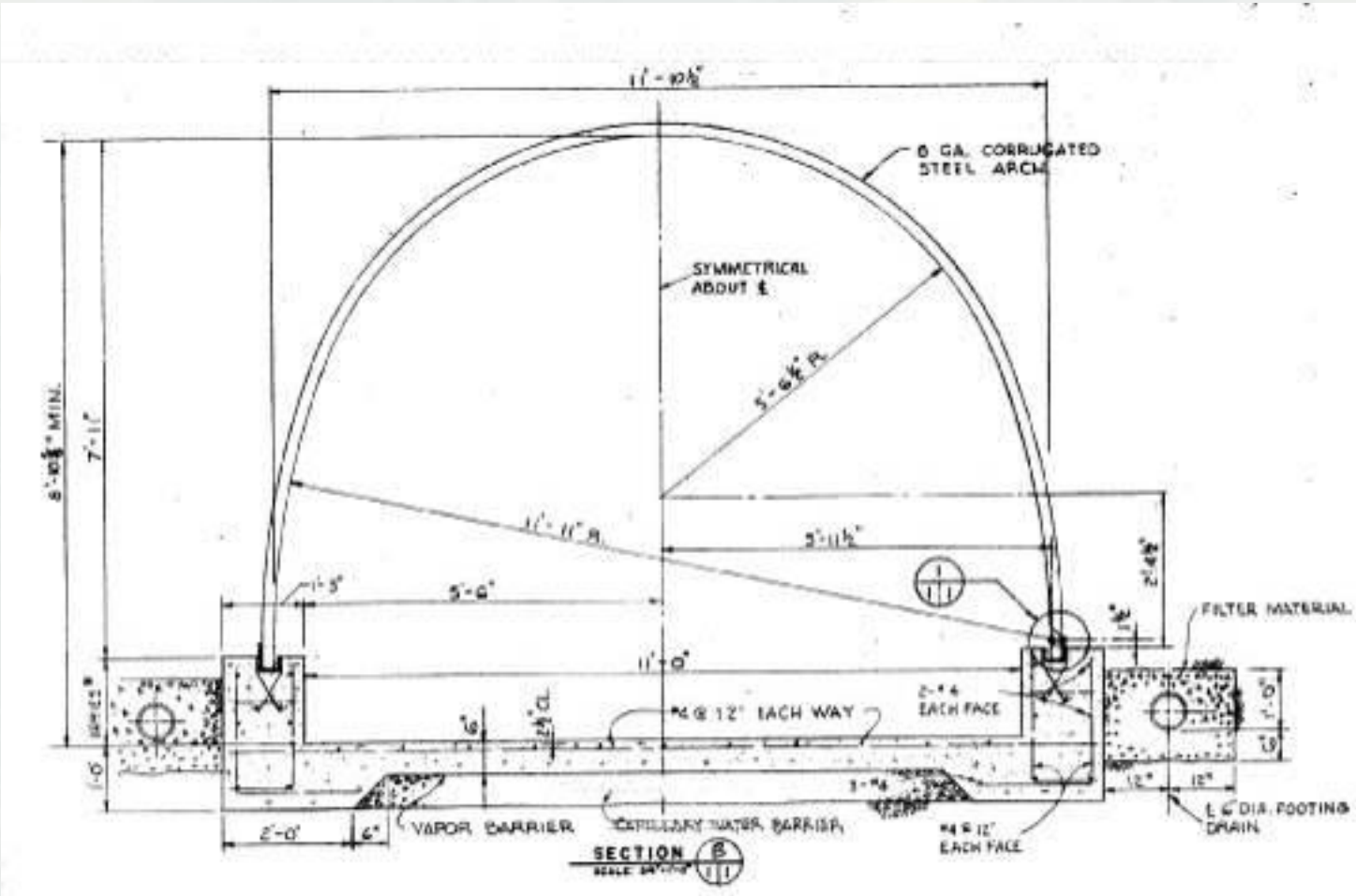
Anodic Reaction

$$Fe + H_2O \longrightarrow FeO + 2H^+ + 2e^-$$

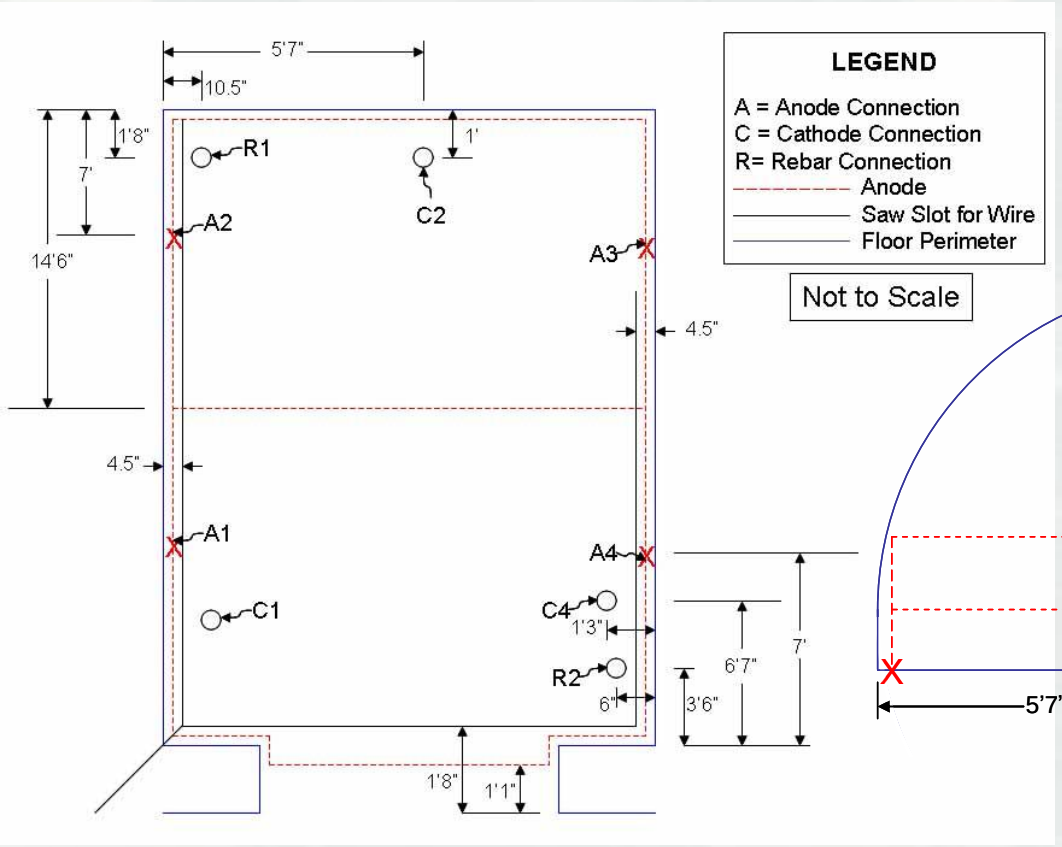
(To remote cathode) ⊖

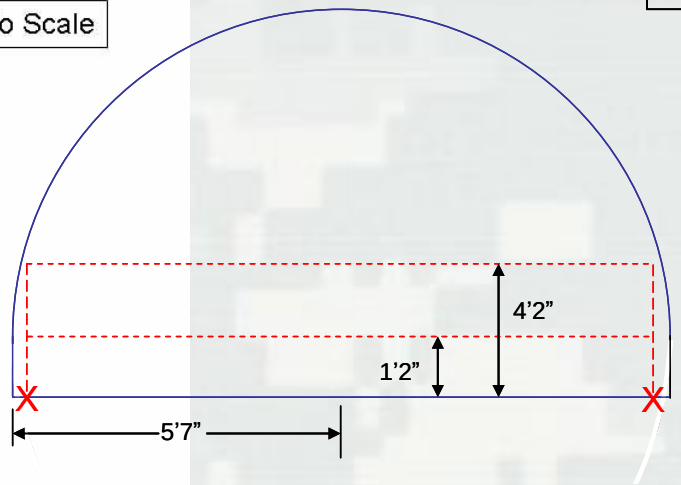
EOP Technology Demonstration

EOP Technology Demonstration



EOP Technology Demonstration





LEGEND

A = Anode Connection
C = Cathode Connection
R= Rebar Connection
Anode
Saw Slot for Wire
Wall Perimeter

Not to Scale

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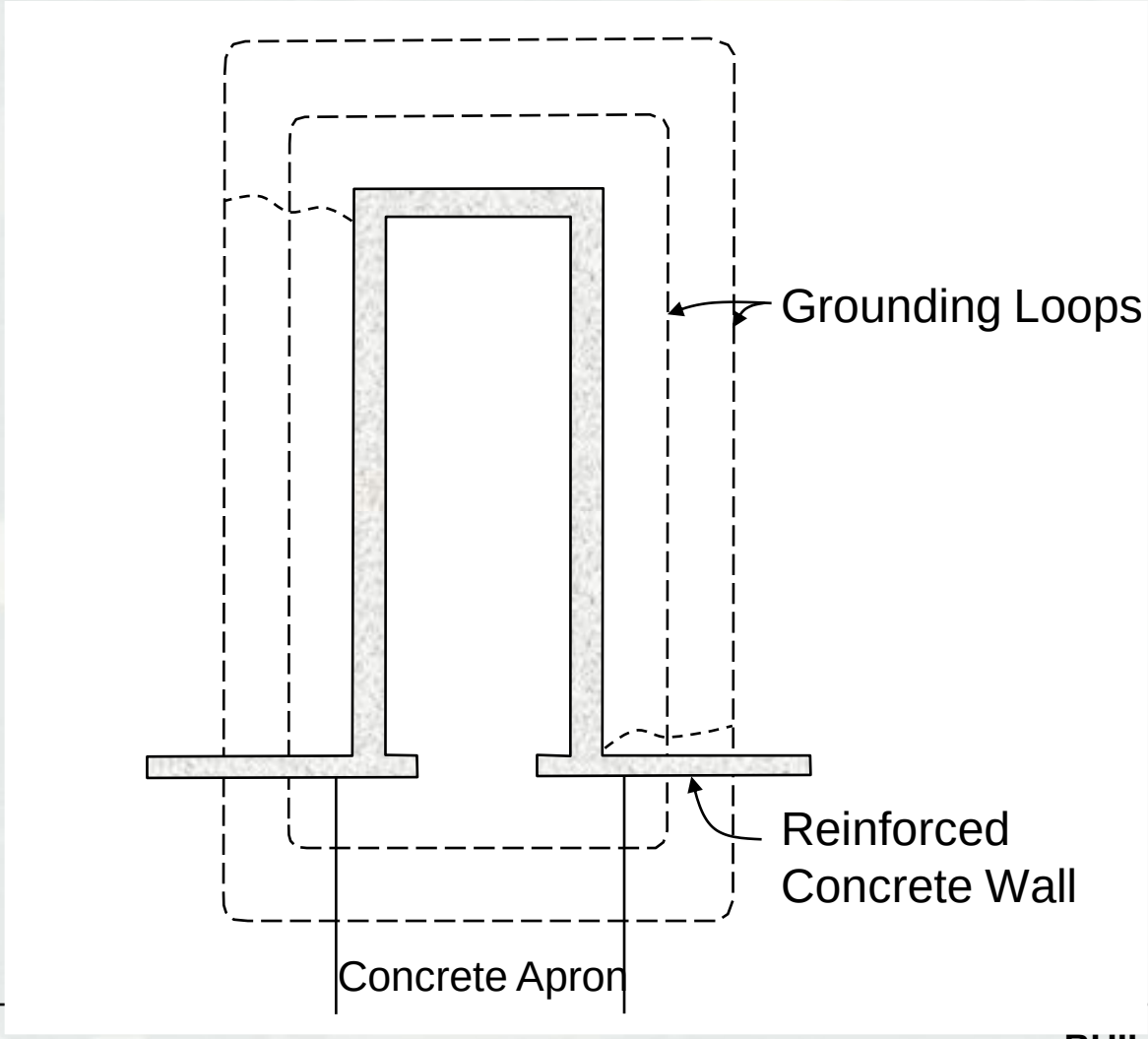
EOP Technology Demonstration

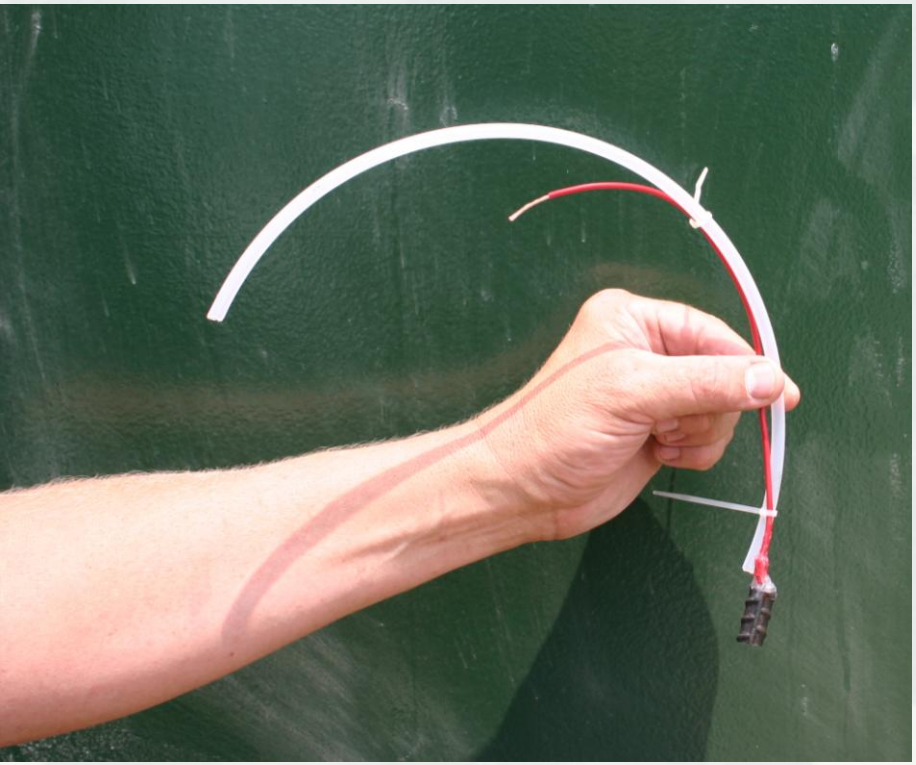
Field Tests and Demonstrations in ECMs

Spark potential of steel arch	None
Spark potential of pallets on floor	None
Spark potential between pallets and arch	None
Hydrogen generation	None
Affects on LPS 	None w/ majority of current to rebar
Water intrusion	Stopped
Electromagnetic radiation	None detected
RF emission	None detected

Typical ECM LPS Layout



Stray Current Test Setup



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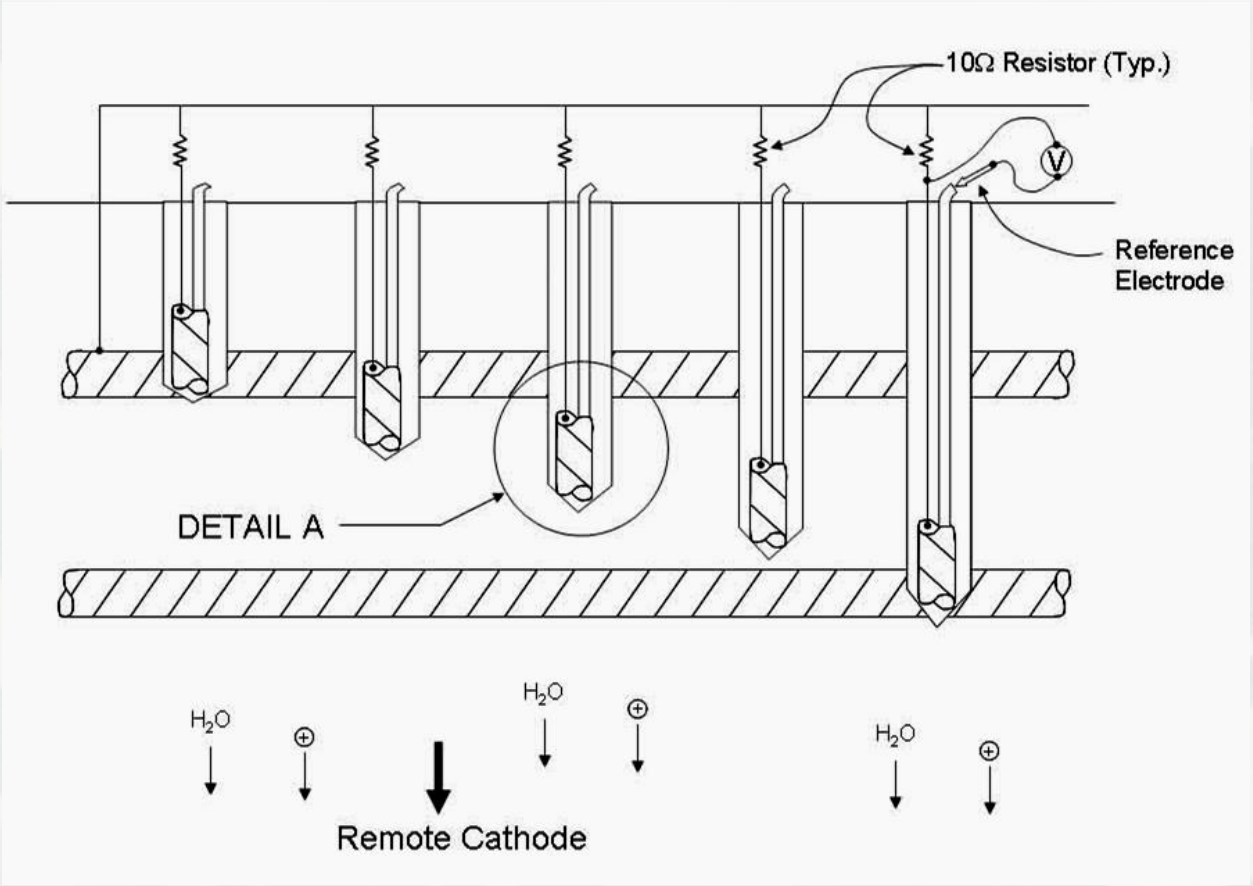
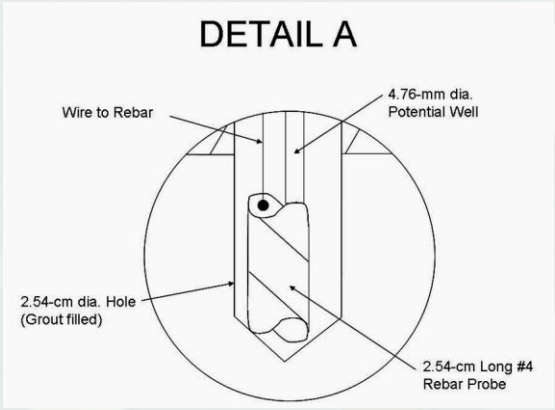




Estimated Current Requirements to Steel

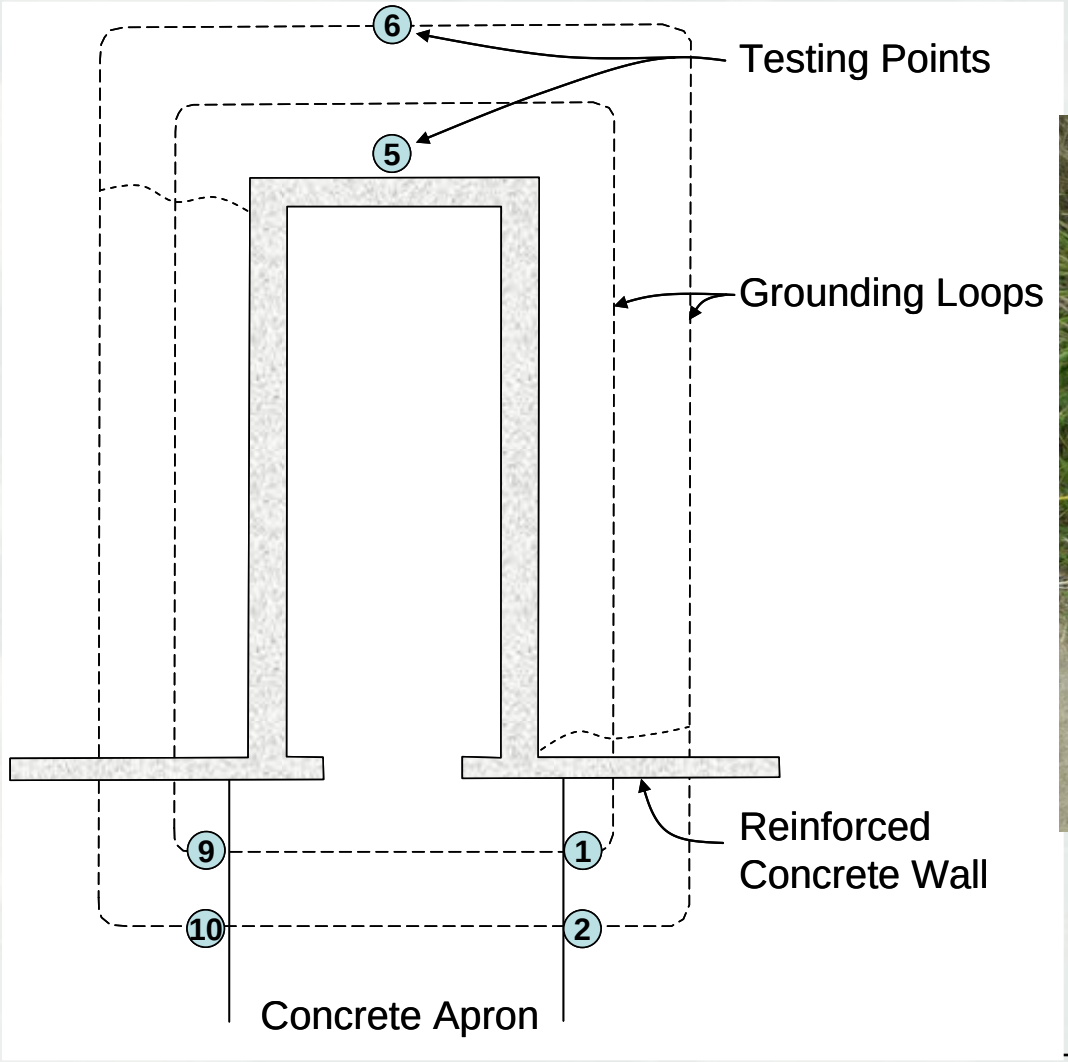
X (cm)	Concrete Resistivity, Ω-cm			
	10,000	15,000	20,000	25,000
2.	0.00 mA (0%)	0.00 mA (0%)	0.00 mA (0%)	0.03 mA (2.2%)
4.	0.00 mA (0%)	0.06 mA (4.2%)	0.12 mA (8.0%)	0.18 mA (12.1%)
6.	0.06 mA (4.2%)	0.16 mA (10.3%)	0.24 mA (16.0%)	0.33 mA (21.7%)
8.	0.12 mA (8.0%)	0.24 mA (16.0%)	0.36 mA (23.8%)	0.47 mA (31.6%)

Assumptions:

Current density of 16.15 mA/m^2

Steel surface area of 0.5 24 m^2/m^2

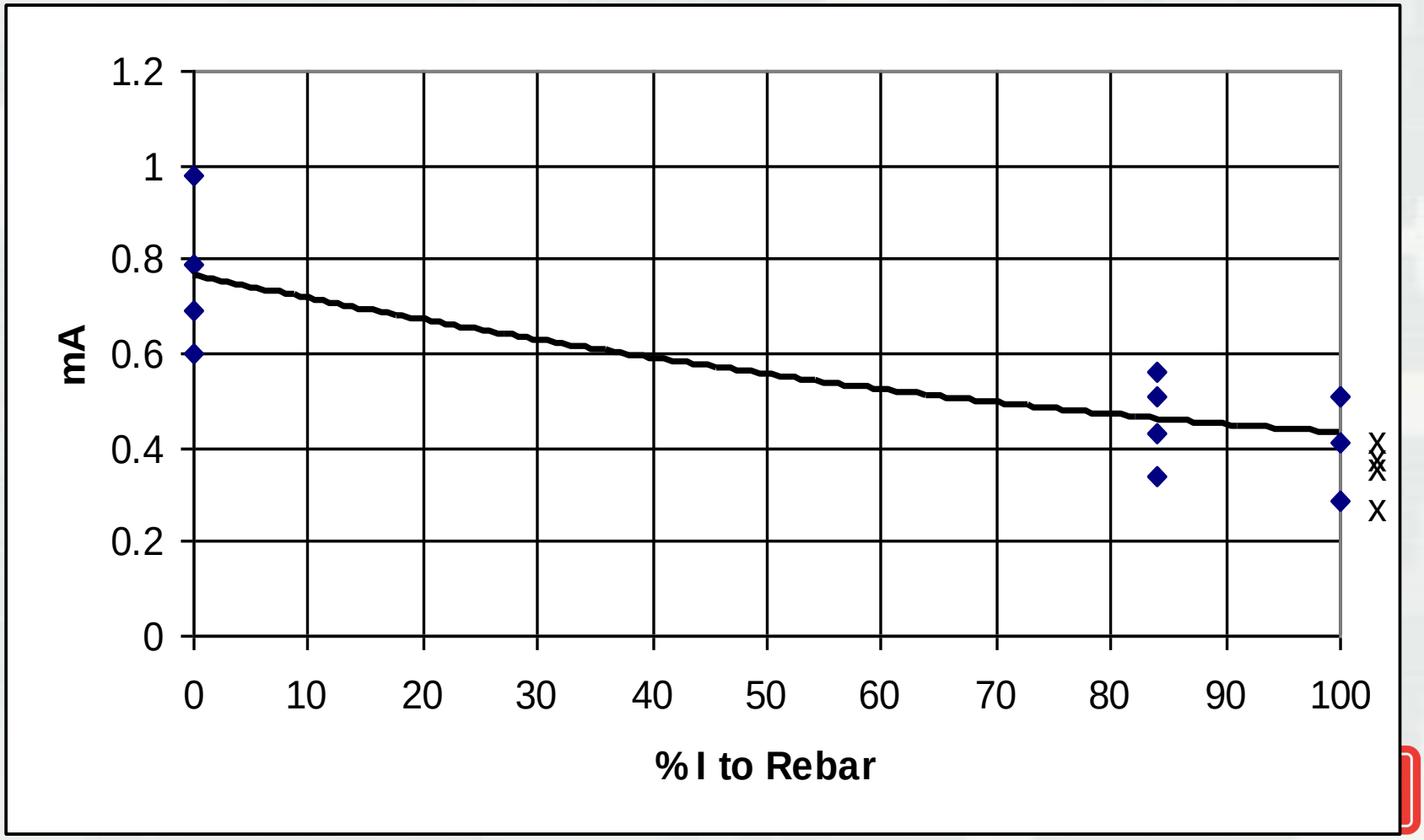
Field Tests


6
Testing Points
5
Grounding Loops
Reinforced
Concrete Wall
9
1
10
2
Concrete Apron

Recommended Field Test Procedure

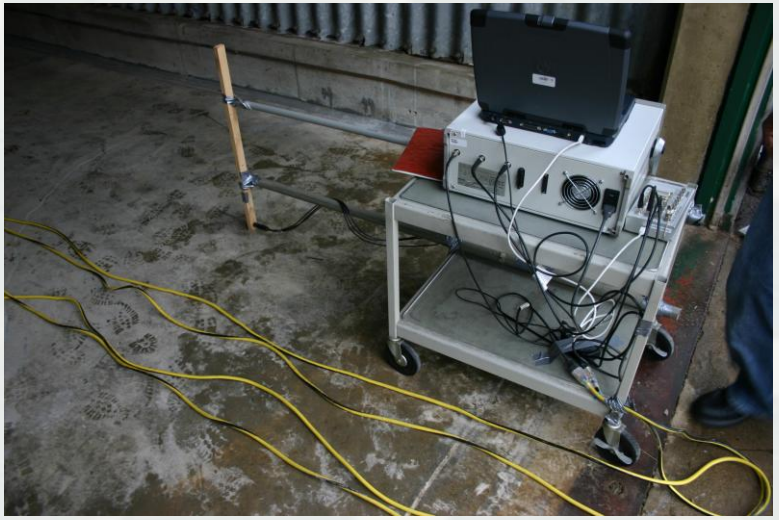
- Locate “most cathodic” and “most anodic” sites
- Install test probes at “most cathodic” and “most anodic” sites
- Take data with the EOP system off and disconnected
- Take data with the EOP system energized
  - Selected percentage from 0-100% of the cathodic current diverted to the reinforcing steel
- Plot current and potential data
- Determine potential for Stray Current Corrosion

Plot of Current Measurements



Field Measurements

RF Emission Testing



EM Emission Testing

Conclusions

- A rebar probe placed above the location of the grounding loops shifted in the anodic direction (corrosive) when attached to the EOP system negative. The anodic shift decreased in magnitude as more current was directed to the reinforcing steel.
- Corrosion current was measured to the rebar probe placed above the location of the grounding loops. The corrosion current decreased in magnitude as more current was directed to the reinforcing steel.

Conclusions

- The corrosive potential and corrosion current recorded when a high percentage of current was directed to the reinforcing steel was not a function of EOP system operation. EOP operated in this way will not cause significant stray current corrosion of elements embedded in the soil.
- With a large percentage of cathodic current directed to the reinforcing steel EOP operation will not result in stray current corrosion of the LPS or structural steel of the magazines.

Discussions