Re-alkalization and Galvanic Protection of Reinforced Concrete Structures

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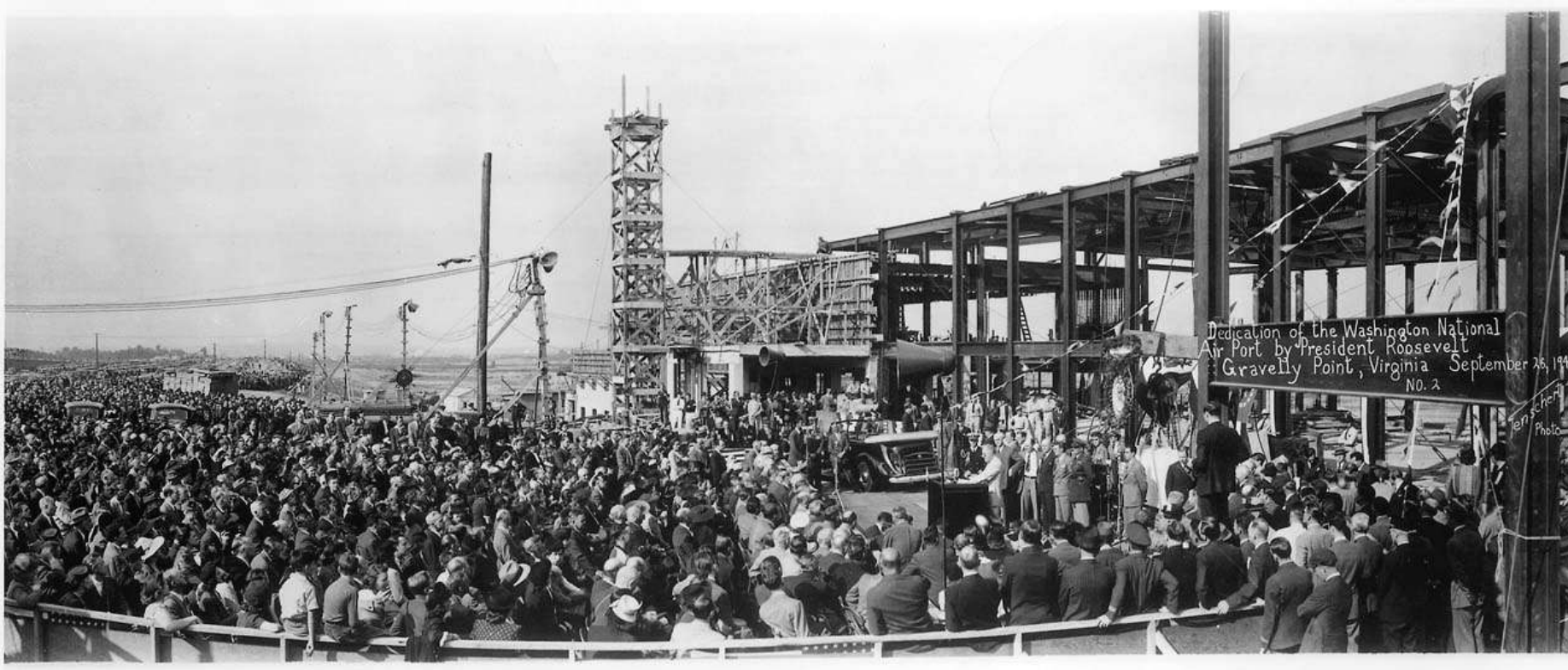
Vector Corrosion Technologies


PCA
The Capital Airlin
PCA

Washington National Airport Dedication; September 18, 1940



Test Program

Test Program

- Photographic Conditions Survey
- Crack Mapping – extensive pattern cracking
- Sounding – revealed correlation between rebar depth and spalling concrete
- Coring – revealed carbonation ¾” to 1 ½”
  - chlorides in one section
- Pachometer – revealed variable rebar depth
- Half-cell Potential - inconclusive

Rebar Issues

Corrosion Due to Carbonation and Low Concrete Cover over Rebar.

Corrosion Mitigation Options

- Galvanic Protection
- Impressed Current Cathodic Protection
- Corrosion Passivation using Electrochemical Treatments
  - Chloride Extraction
  - Re-alkalization

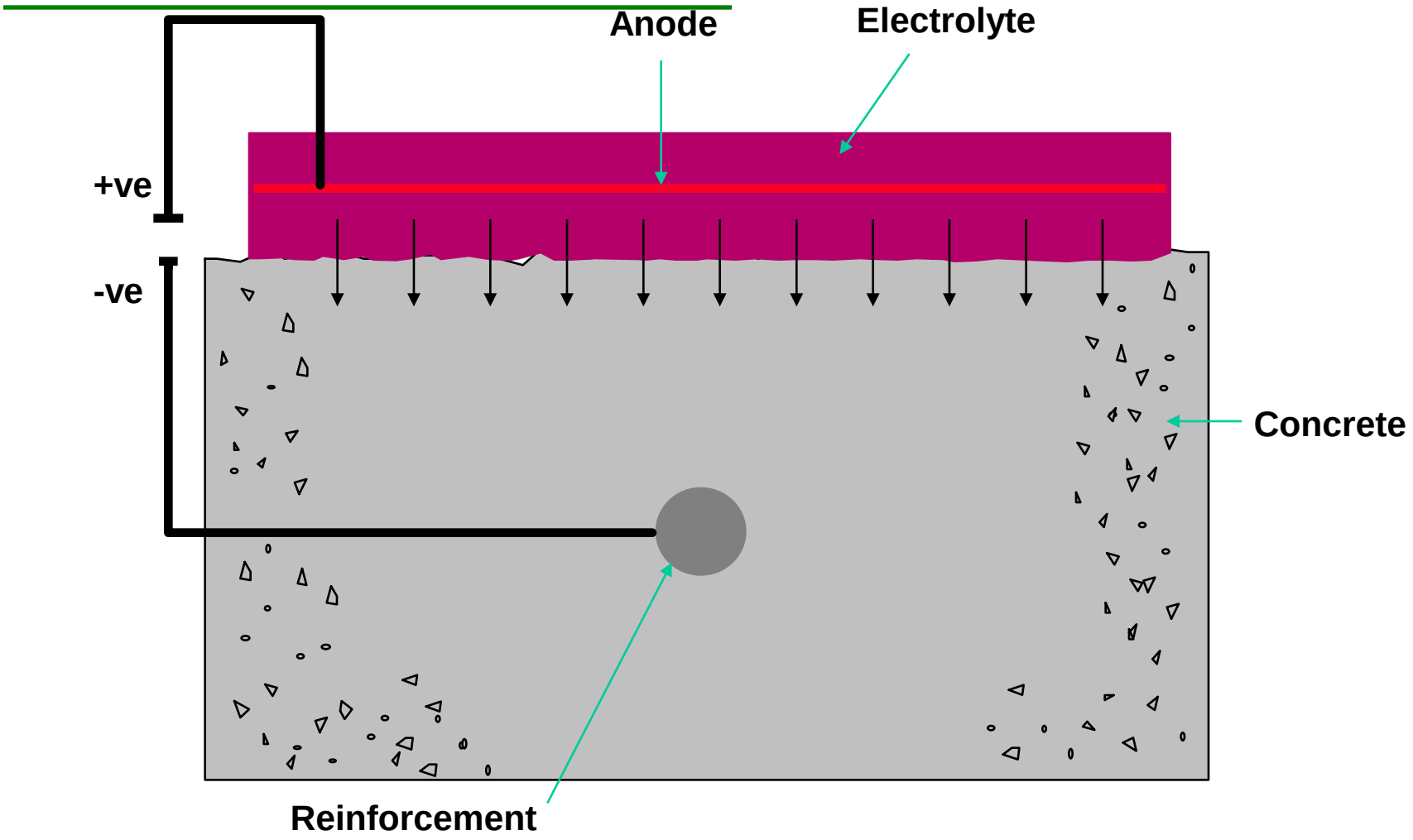
Washington National Airport Façade Repair Program

- Install site protection
- Remove loose concrete
- Chemically strip paint
- Abrasive cleaning and surface preparation
- Replace corroded rebar and patch concrete
- Realkalisation of all exposed concrete
- Apply coating
- Perform all other work (roofing, railings, etc)

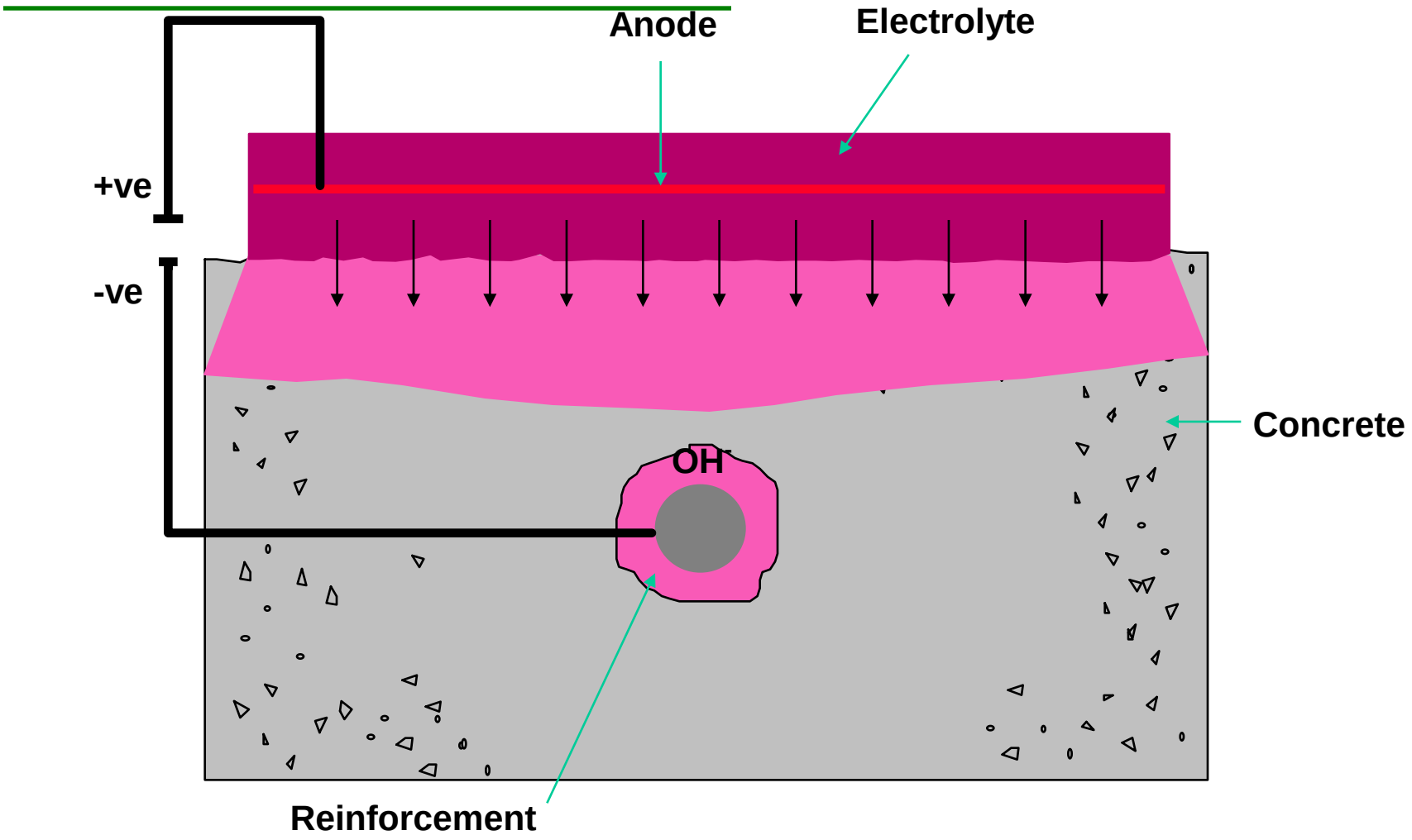
Realkalization

- Draws highly alkaline electrolyte sodium carbonate (Na_2CO_3) to the reinforcing steel
- Restores lost alkalinity to carbonated concrete
- Alkalinity around reinforcing steel is maintained over time, will not re-carbonate
- Lower cost, less disruptive that mechanical removal and replacement of carbonated concrete

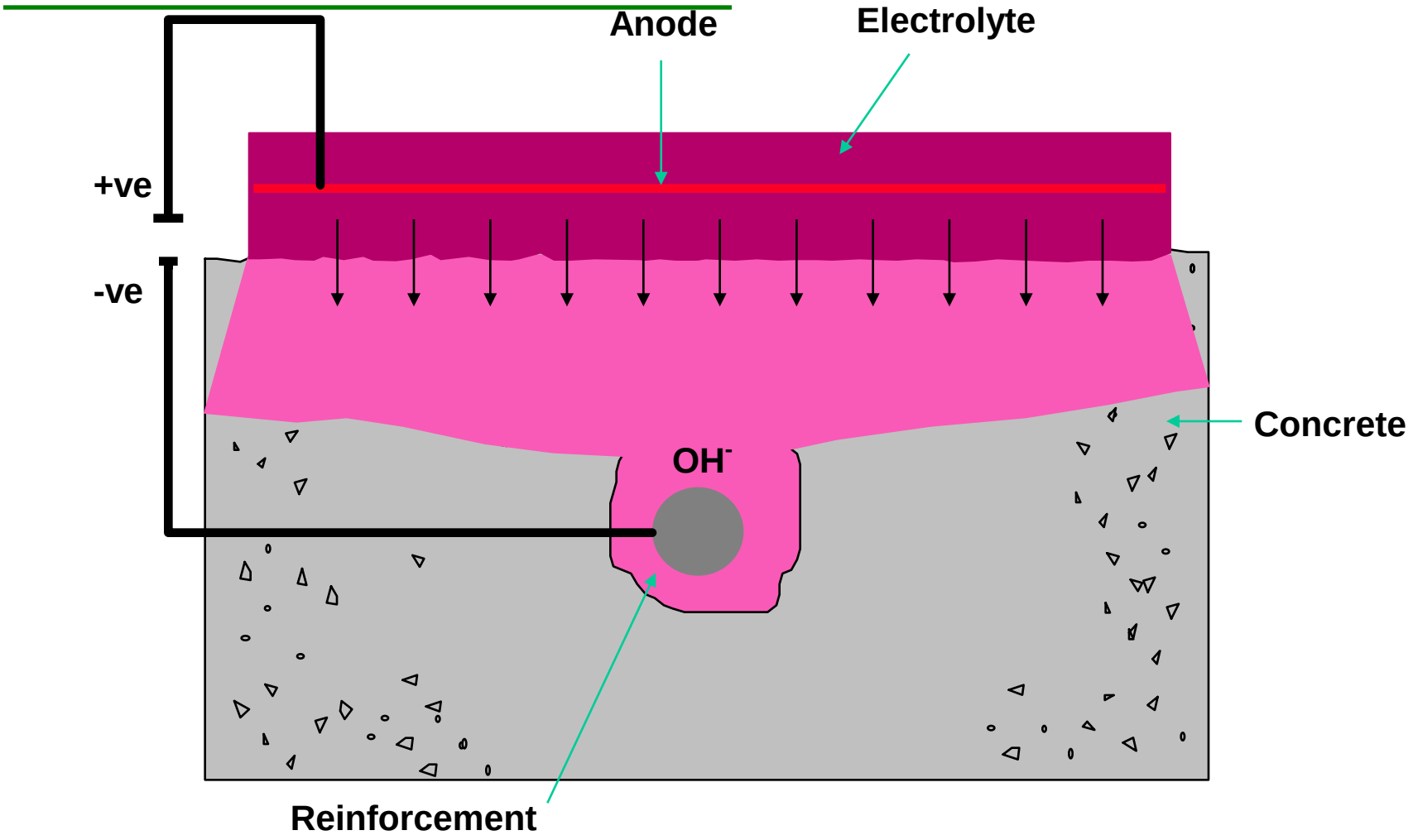
Realkalization



Realkalization



Realkalization



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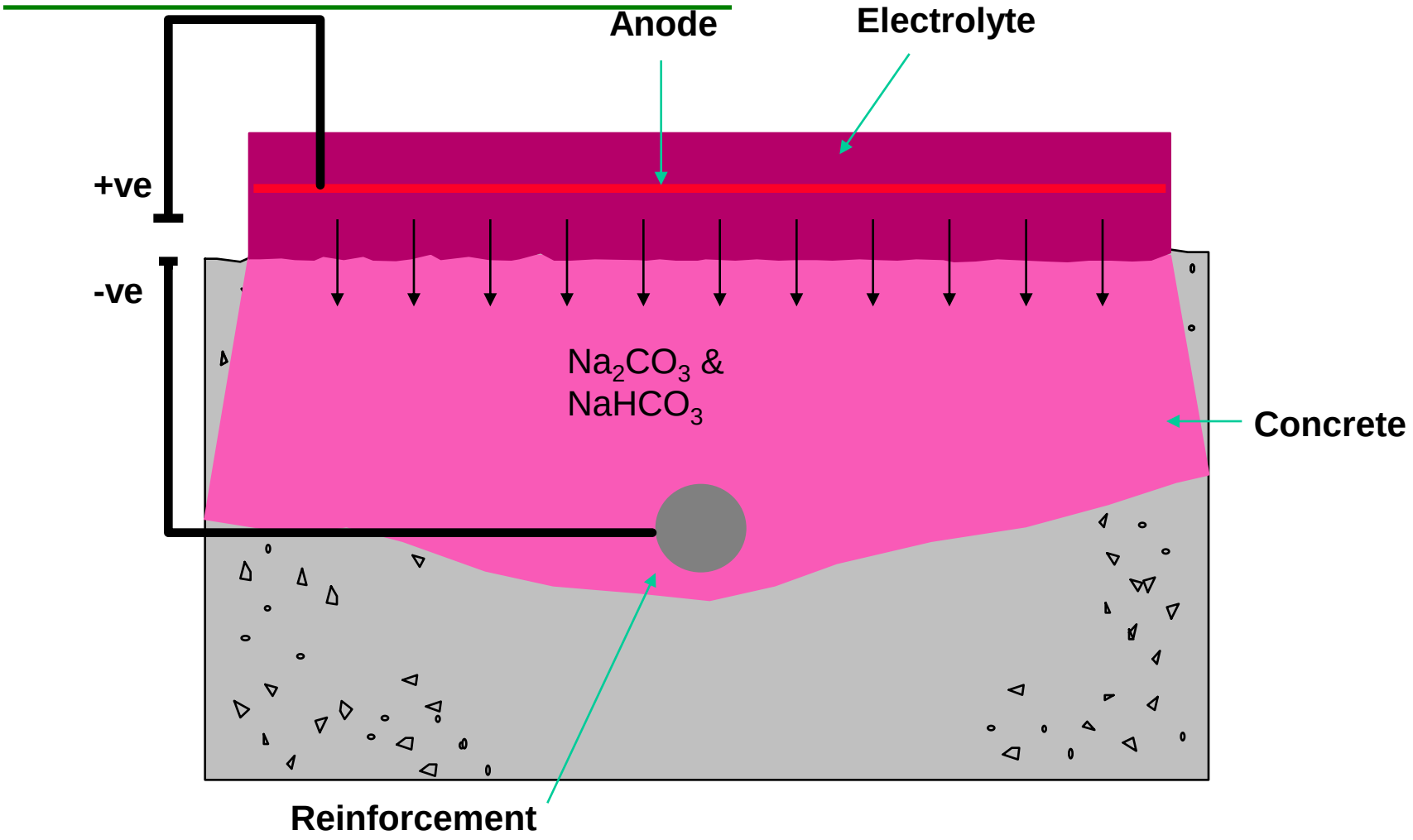

Access & Protection

- Protection of windows in occupied areas.
- Access to work areas for all project elements.


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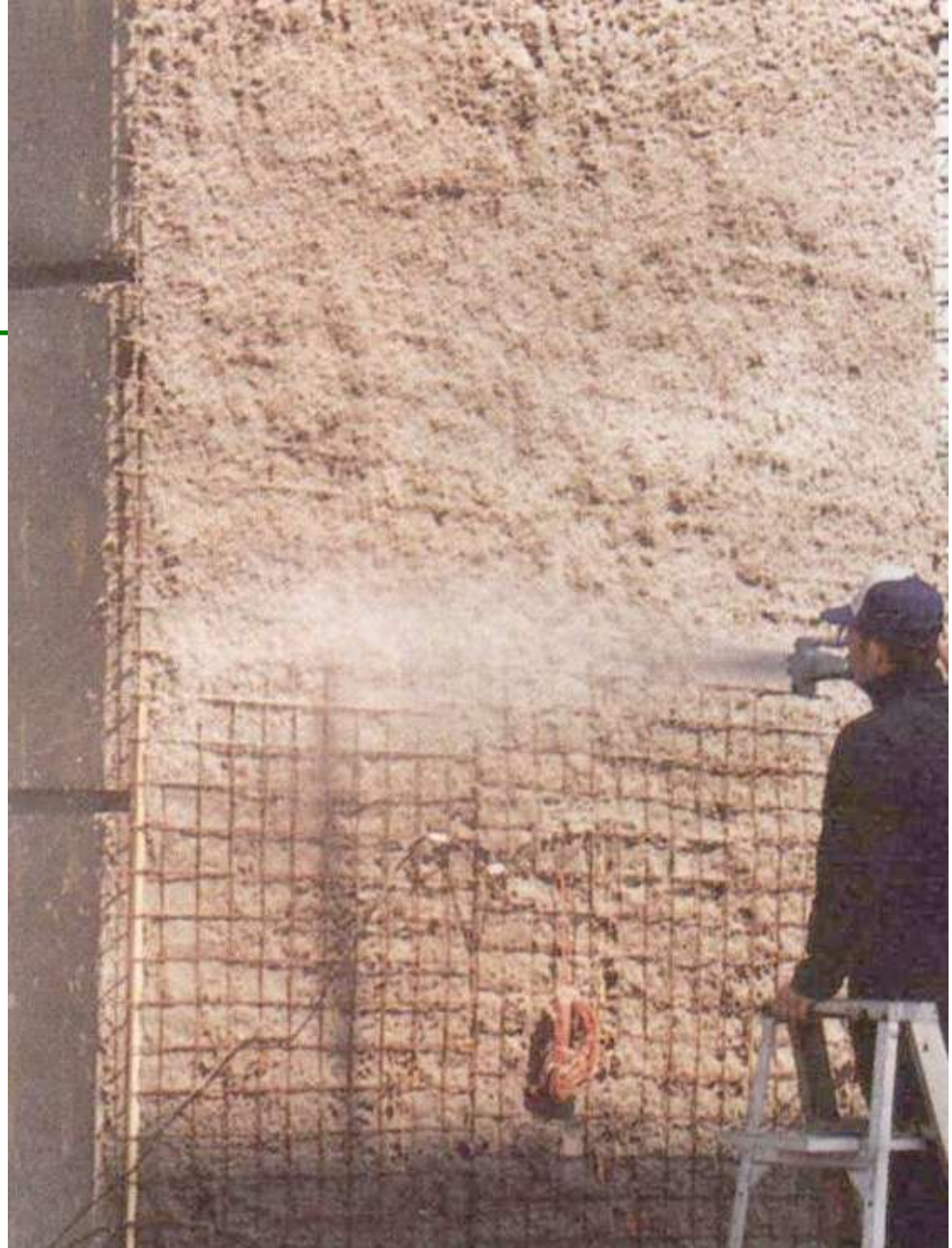
Norcure® Chloride Extraction and Re-alkalization of Concrete Facade.

Reagan National Airport
Washington, DC



Verification of Results

- Phenolphthalein Testing on Cores

Before

After Realkalization

Realkalization - Results

- Highly alkaline zone around steel
- Strong passivation occurs
- Cover zone impregnated with potassium carbonate, high final pH
- Low alkalinity problem is rectified
- Entire surface treated
- No further corrosion

Image courtesy of Eric Taylor

- Ohio DOT
- I-75 Substructure Restoration

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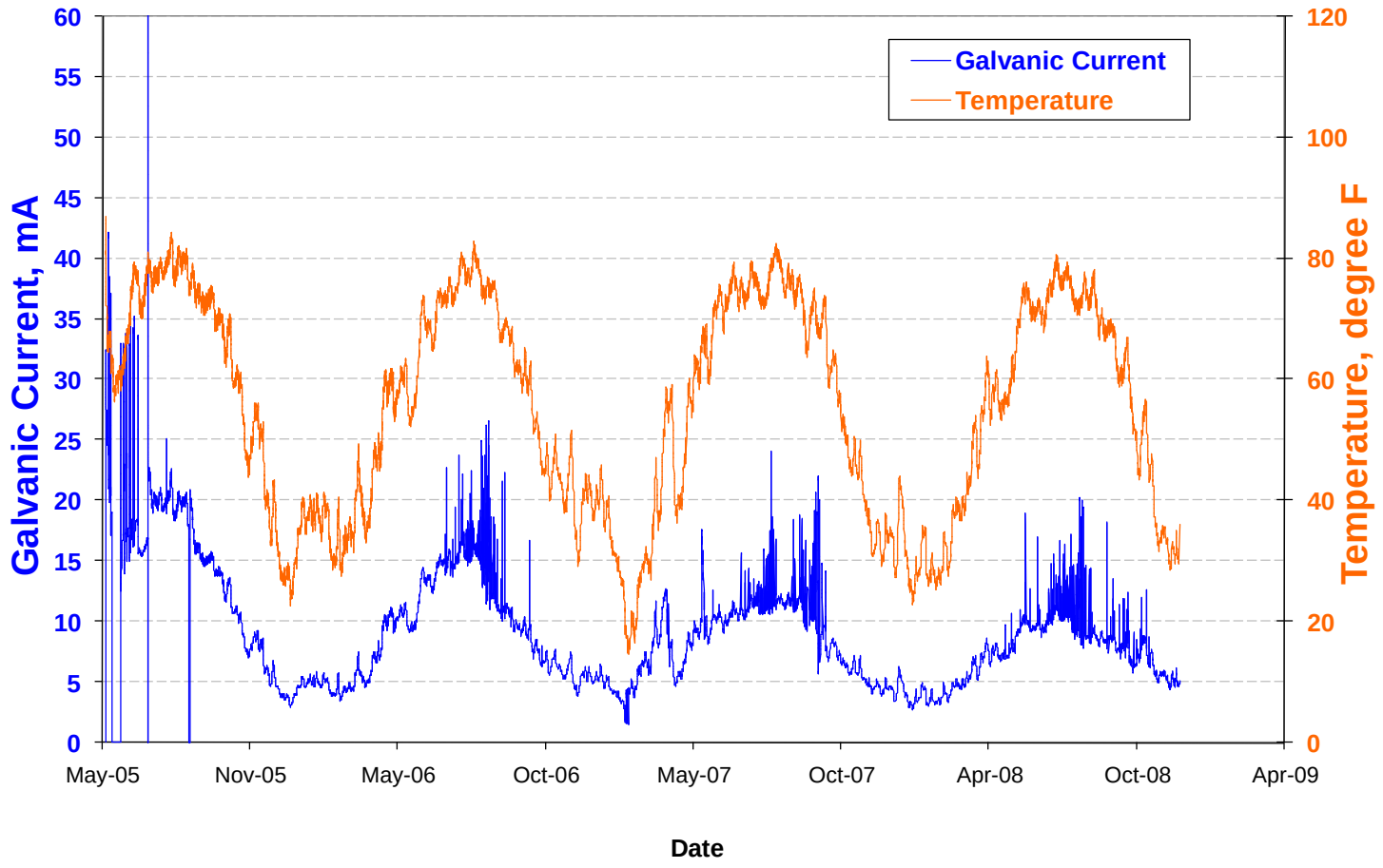
Completed repair

Kirkwood Road – Protective Current



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	31	12.9	333	987
10/26/05	12	5.4	394	1048
12/7/05	11	3.2	339	993
5/1/06	14	7.5	335	989
12/20/06	4	4.3	500	1154
5/30/07	26	7.5	446	1100
9/20/07	24	9.7	484	1138
12/09/08	4	3.3	470	1124
7/9/09	23	3.3	475	1129

Presentation Summary:

- Corrosion of Steel in Concrete
- Types of Corrosion Protection Systems
- Electrochemical Treatments
  - Re-alkalization
- Galvanic Protection
- Project Examples

Thank You

Vector Corrosion Technologies

www.vector-corrosion.com

Questions

Compliments of Computer History Museum

Sustainability and the Environment

Concrete in Society

- Concrete is the most widely used man-made product in the world
- 6 Billion tons per year (~4 Billion m^3)
- Huge consumer of raw materials and energy
  - Cement
  - Aggregate
  - Concrete production and transport
  - Steel production is also energy intensive

Concrete in Society

- Overall Total CO_2 produced
  - Cement: 1 Billion tons CO_2 per year
  - Aggregate: ~ 50 Million tons CO_2 per year
  - Ready Mix: 150^+ Million tons CO_2 per year
  - Rebar: 200 Million tons per year
- Total CO_2 produced: ~ 1.5 Billion tons / yr

Concrete in Society

- Other Emissions
  - Carbon Monoxide: 10 Million tons per year
  - Nitrogen Oxides: 30 Million tons per year
  - Sulfur Dioxide: 29 Million tons per year
  - Volatile Organic Compounds: (VOC's)
    2 Million tons per year
- Thermal pollution is also significant.

Concrete in Society

- Thermal pollution from concrete production is ~ 8 Billion GJ / yr.
- 1 GJ = A lot of Heat
- This is enough heat energy to raise the temperature of 1 million square kilometers of water (1 meter deep) by 1^{o}C / year. (3 feet deep by 2^{o}F / year)

ICRI Project of the Year
Norcure® Electrochemical Chloride Extraction

Historic Rainbow Bridge
Cascade, ID

50 Year Life Extension to a 75 Year Old Structure

Rainbow Bridge Rehabilitation

- 50 year service life extension.
- 1,809 yd^3 of concrete were maintained in service.
- Reduced CO_2 emissions by ~ 450 tons.
- Prevented the release of 4,800 GJ of heat. (enough heat to boil 3 Olympic Pools)
- Equivalent to annual emissions of 90 people

ICRI Award of Excellence for Concrete Rehabilitation Longevity.

Seven Sister's Generating Station 1981
Manitoba, Canada

INTERNATIONAL CONCRETE REPAIR INSTITUTE

Seven Sisters Rehabilitation

- 40 - 50 year service life extension.
- 38,000 yd^3 of concrete were maintained in service.
- Reduced CO_2 emissions by 9,500 tons.
- Equivalent to annual emissions of 1,900 people.

Call to Action

- This is Important
- Think about the Reality,
- Accept Responsibility, and
- Take Action

Thank You

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Questions

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