Corrosion Mitigation Strategies for Concrete Structures

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Presentation Agenda

- Corrosion Protection Strategies

- Explain Why this is Important

SHRP2 R19A


Bridges for Service Life Beyond 100 Years
Innovative Systems, Subsystems, and Components
SHRP2 RENEWAL RESEARCH
SHRP 2
TRANSPORTATION RESEARCH BOARD

Why is this Important?

- Impact of Construction Activities
- Construction is the single largest consumer of resources and raw materials
- Almost 50% of all raw materials produced are used in construction
- Construction and demolition generate about 40% of all solid waste

Concrete

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

Environmental Impact of Concrete

- Concrete has a significant environmental impact
- ~ 1.5 Billion tons of CO_2 per year
- Other Emissions
  - Carbon Monoxide: 9.5 Million tons per year
  - Nitrogen Oxides: 30 Million tons per year
  - Sulfur Dioxide: 29 Million tons per year
  - Volatile Organic Compounds: (VOC's)
    1.8 Million tons per year
- Thermal pollution is also significant.

Responsible Use of Concrete

- Despite the environmental impact, concrete is one of the most environmentally friendly materials available if we build structures to last or extend the life of existing structures.

Corrosion Prevention Strategies

- For New Structures:
- Design with Service Life in Mind
- Prevent Corrosion from Initiating
  - Design Structures which are Immune to Corrosion
  - Keep Water and Salt Away from Reinforcing Steel


Confederation Bridge
100 Year Design Life

Corrosion Prevention Strategies

- For Existing Structures:
  - Understanding the condition of the structure is Key
  - Have sufficient chlorides penetrated?
- If Chlorides Have Not Penetrated
  - Do what you can to keep them out
- If Chlorides Have Penetrated
  - Useful to keep more chlorides and water out but probably need to do more

Corrosion Prevention Strategies

- Chloride Contaminated Structures
  - Some type of active protection is generally required to achieve long service life
- Impressed Current Cathodic Protection
- Electrochemical Treatment
- Galvanic Protection
- Fusion Systems

TECHNICAL

GUIDELINES

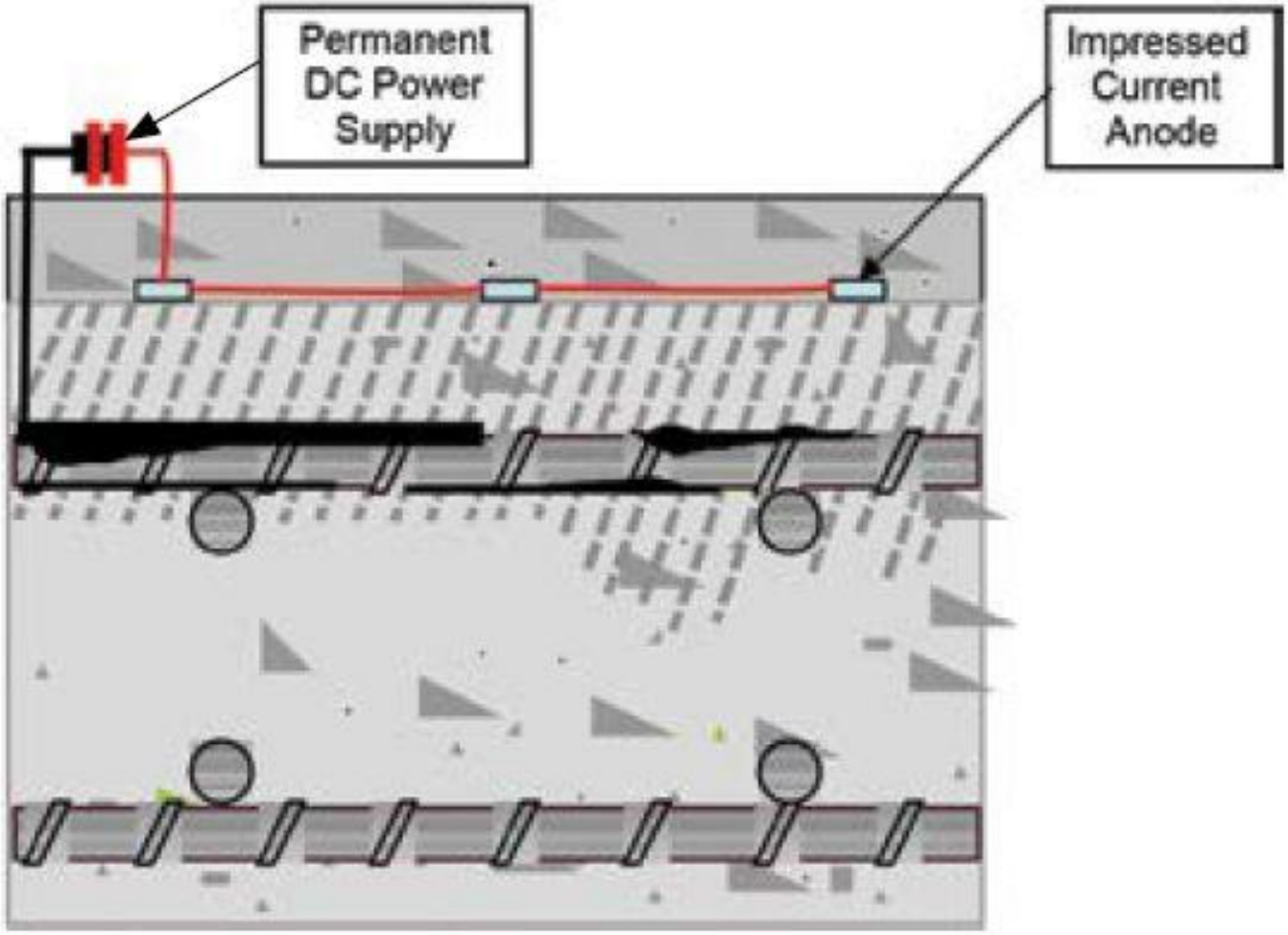
Prepared by the International Concrete Repair Institute June 2013



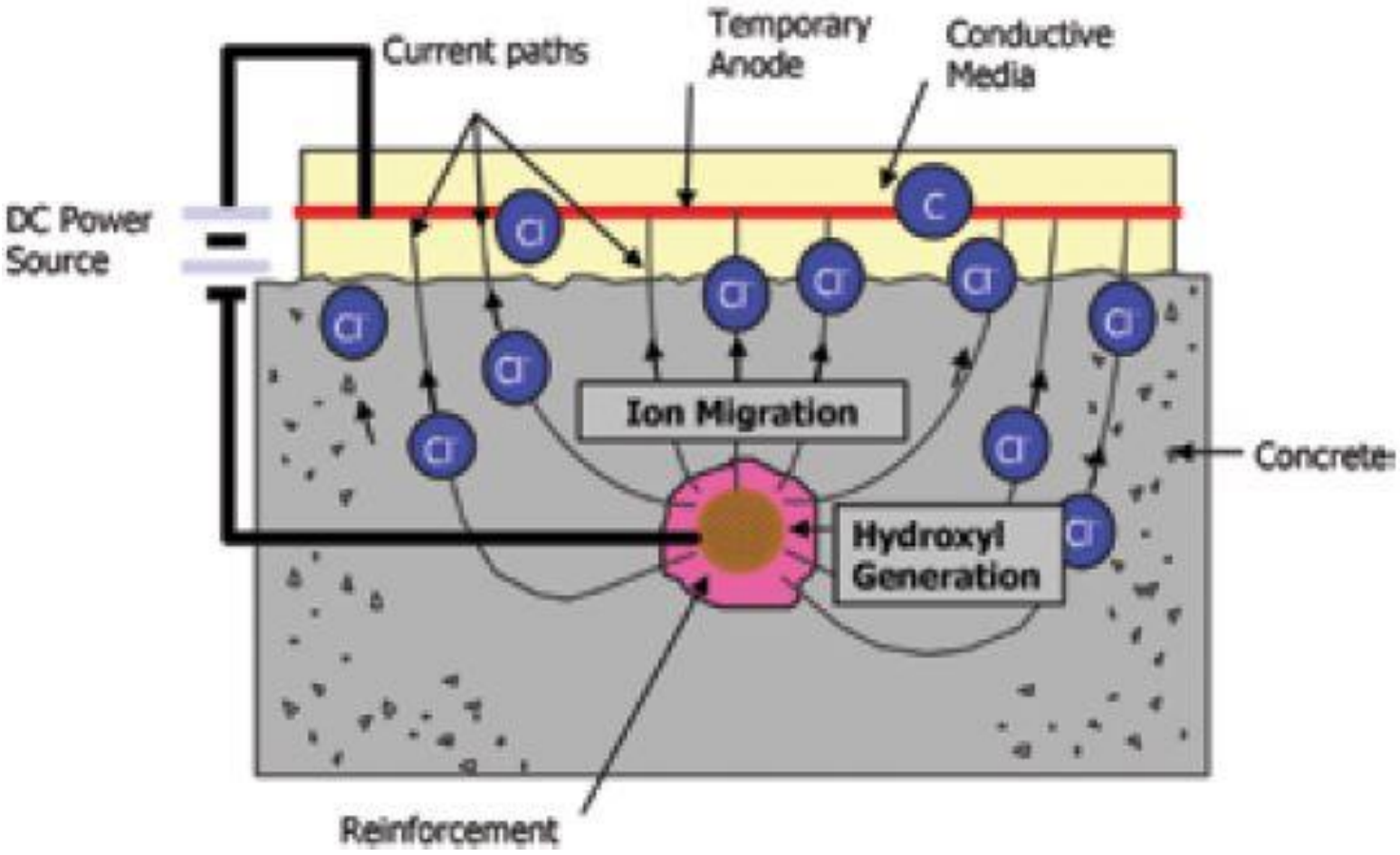

Guideline No. 510.1-2013

Guide for Electrochemical Techniques to Mitigate the Corrosion of Steel for Reinforced Concrete Structures

Impressed Current Cathodic Protection (ICCP)

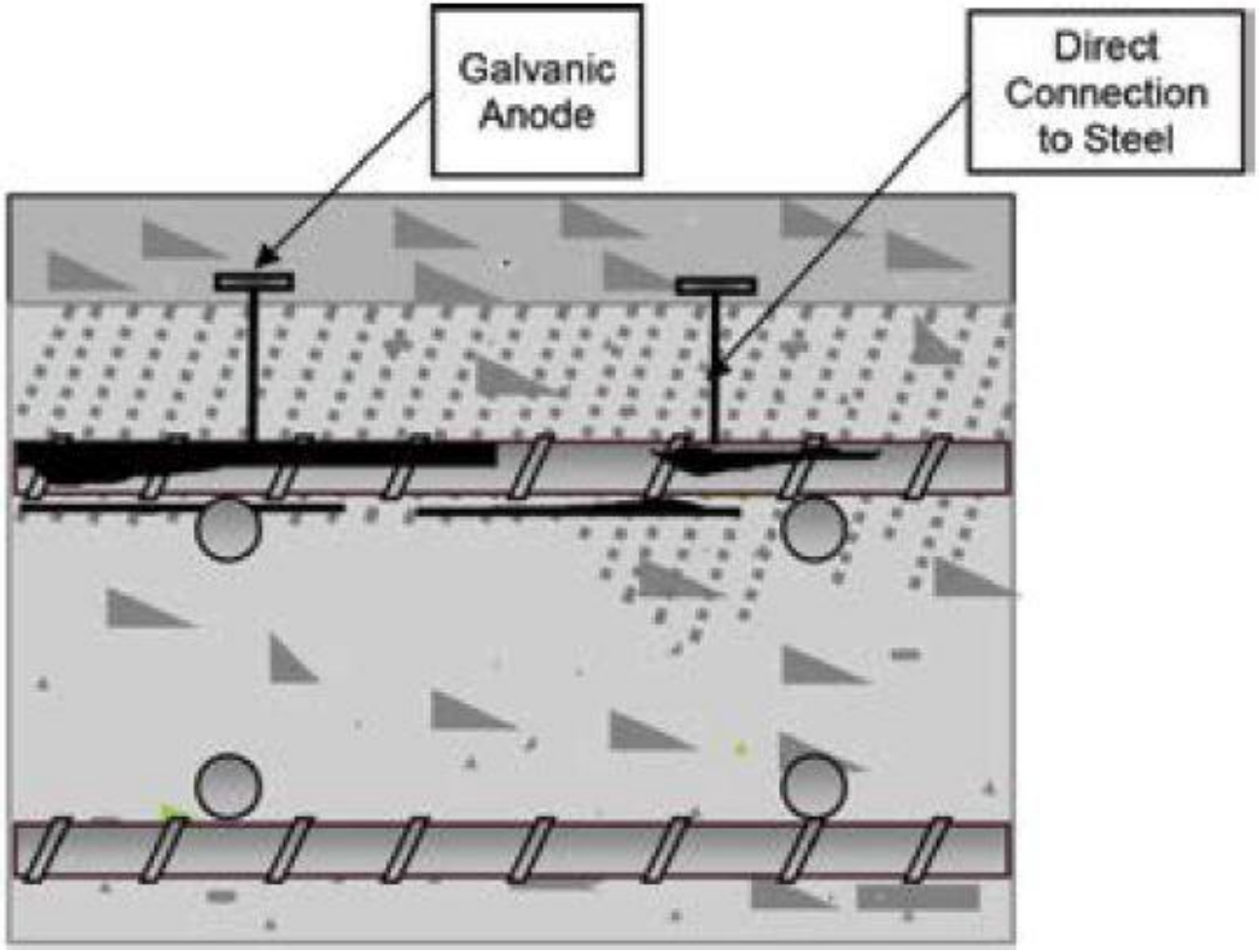


Electrochemical Chloride Extraction (ECE)



Electrochemical Chloride Extraction (ECE)

Galvanic Cathodic Protection (GCP)



Discrete Galvanic Anodes

ACI Vision 2020

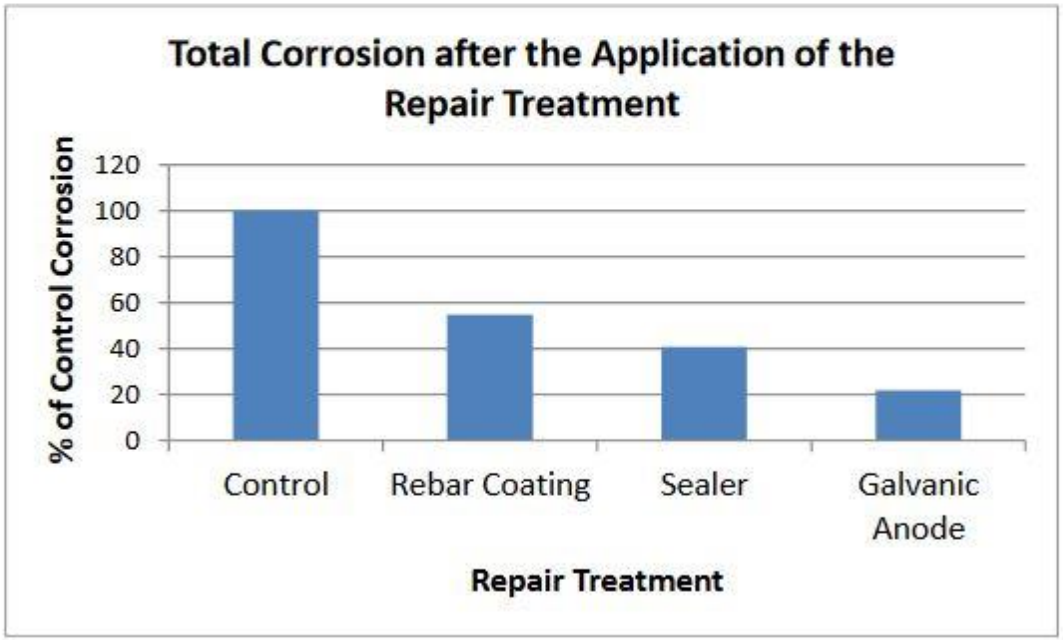


Figure 8 – Comparison of the performance of repair treatments for Batch #1.

INTERNATIONAL CONCRETE REPAIR INSTITUTE

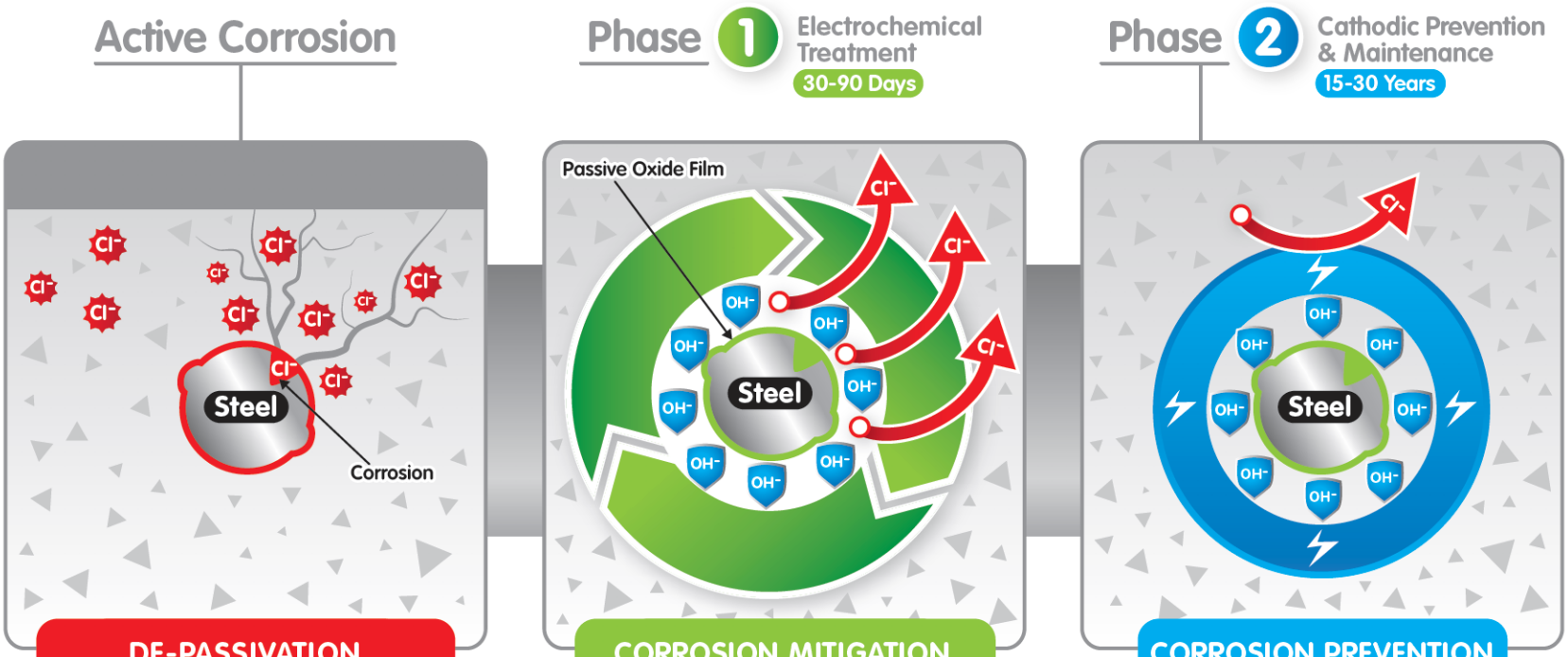
Galvanic Jackets

Fusion Systems

- Combine the Benefits of Impressed Current, Electrochemical Treatments and Galvanic Protection

1. Self-Powered Impressed Current to Passivate Actively Corroding Steel
2. Galvanic Protection to Maintain Passivity (no maintenance required)

Fusion Systems



DE-PASSIVATION & CORROSION

- Chloride Ions enter the concrete
- Chlorides break down passive film
- Corrosion initiates
- Acidic corrosion pits form on the steel
- Rust forms and occupies 7-12x the volume
- Stress builds within the concrete
- Cracking & rust staining is visible

CORROSION MITIGATION & RE-PASSIVATION

- High charge density delivered
- Alkalinity restored around steel
- Chlorides pushed away from steel surface
- Corrosion mitigated in pits
- Steel passivity is restored

CORROSION PREVENTION & MAINTENANCE

- On-going protective current delivered to steel
- Steel passivity is maintained
- Chloride continues to be repelled
- Alkalinity continues to increase

Structure protected for up to **30+ YEARS**

Fusion Systems

Concluding Remarks

- There are many good reasons to design and build more durable bridges
- It is economically, socially and environmentally beneficial to invest our resources in maintaining our existing infrastructure instead of demolishing and rebuilding what we already have


THINK

Thank You for Your Time and Attention

?

We Save Structures