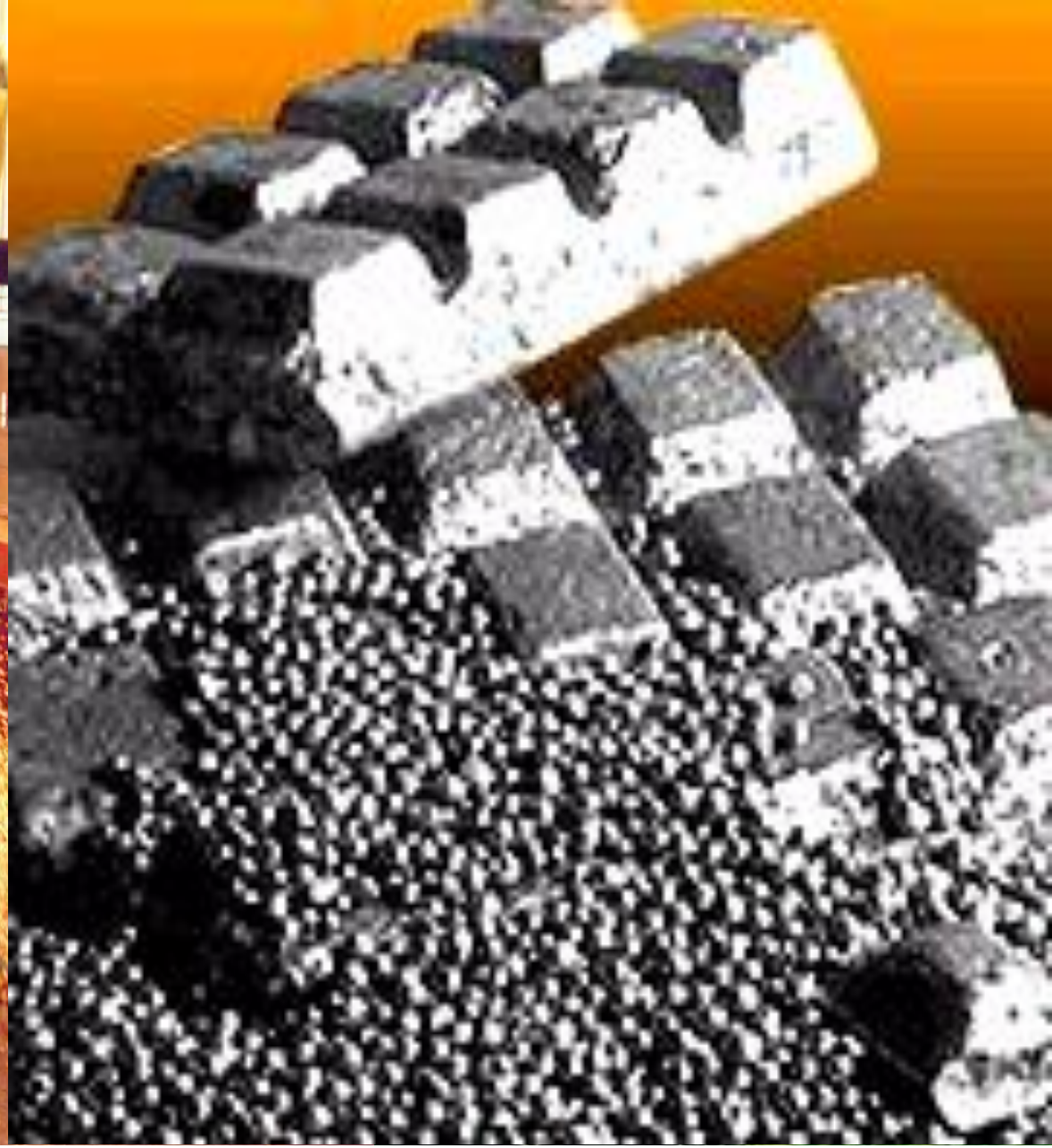
Mott MacDonald

Corrosion of Steel in Concrete

Dr Chris Atkins



STRUCTURAL CONCRETE ALLIANCE
ASSET PROTECTION & REPAIR

The voice of the concrete repair and refurbishment industry

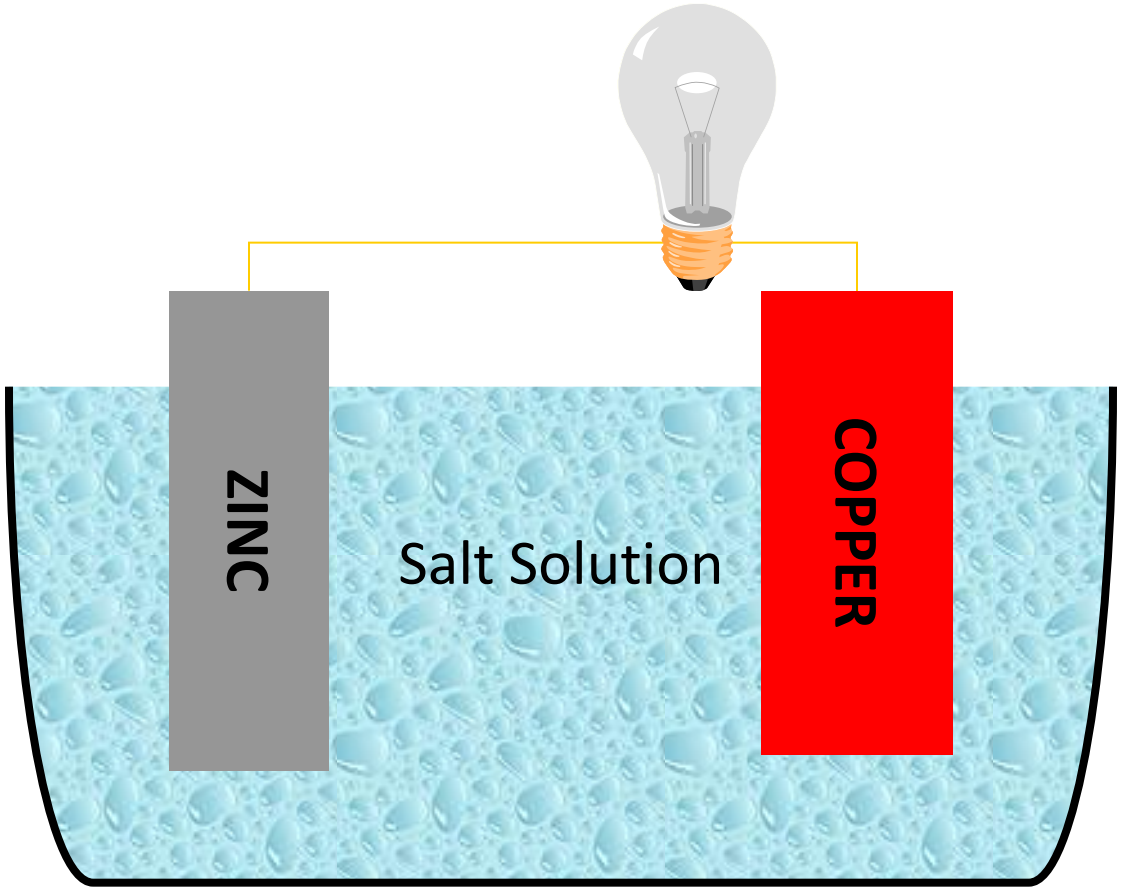
The Structural Concrete Alliance brings together the expertise of:

CONCRETE REPAIR ASSOCIATION
cpa
SCA

How?

- Anodes and Cathodes
- Anode loses Metal
- Cathode reacts with oxygen and water
- El in the Electrolyte

How?



Are you sure?

Steel in Concrete

- Passive Film Protects
- But….
  - Chlorides
  - Carbonation
- Steel Rusts
  - Lose reinforcement
- Rust is bigger than steel
- Bits fall off

STRUCTURAL CONCRETE ALLIANCE
ASSET PROTECTION & REPAIR

The voice of the concrete repair and refurbishment industry

The Structural Concrete Alliance brings together the expertise of:

CONCRETE REPAIR ASSOCIATION

cpa

SCA

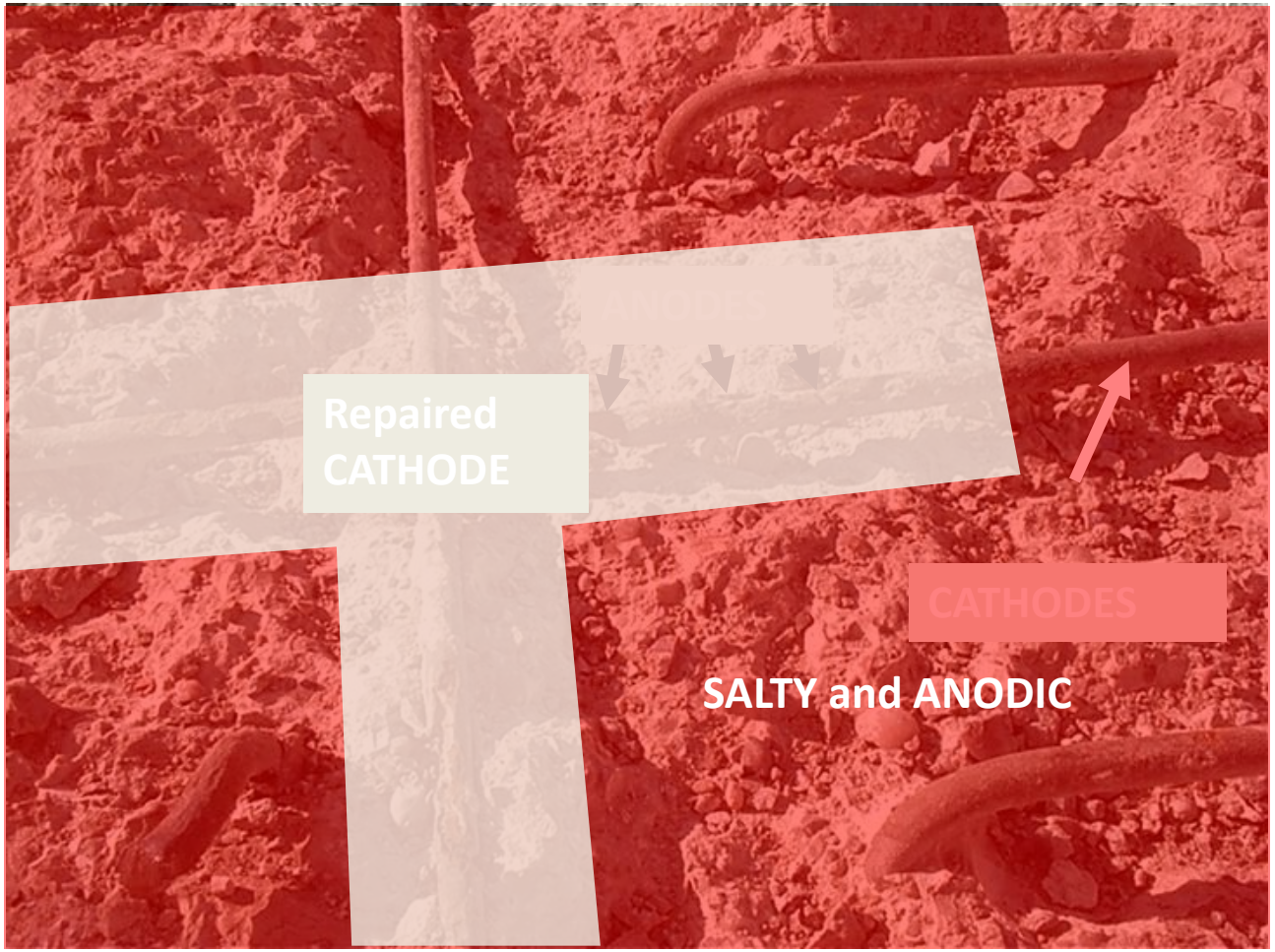
STRUCTURAL CONCRETE ALLIANCE
ASSET PROTECTION & REPAIR

The voice of the concrete repair and refurbishment industry

The Structural Concrete Alliance brings together the expertise of:

CONCRETE REPAIR ASSOCIATION
cpa
SCA

Steel in Concrete - Chlorides



STRUCTURAL CONCRETE ALLIANCE
ASSET PROTECTION & REPAIR

The voice of the concrete repair and refurbishment industry

The Structural Concrete Alliance brings together the expertise of:

CONCRETE REPAIR ASSOCIATION
cpa
SCA

Chlorides

- Find steel
- Miss steel
- Drill hole
- Ignore first 5mm
- Collect dust at depth increments
- Send off for analysis
- Dust can be used for
- Cement content
- Sulphates

Cover

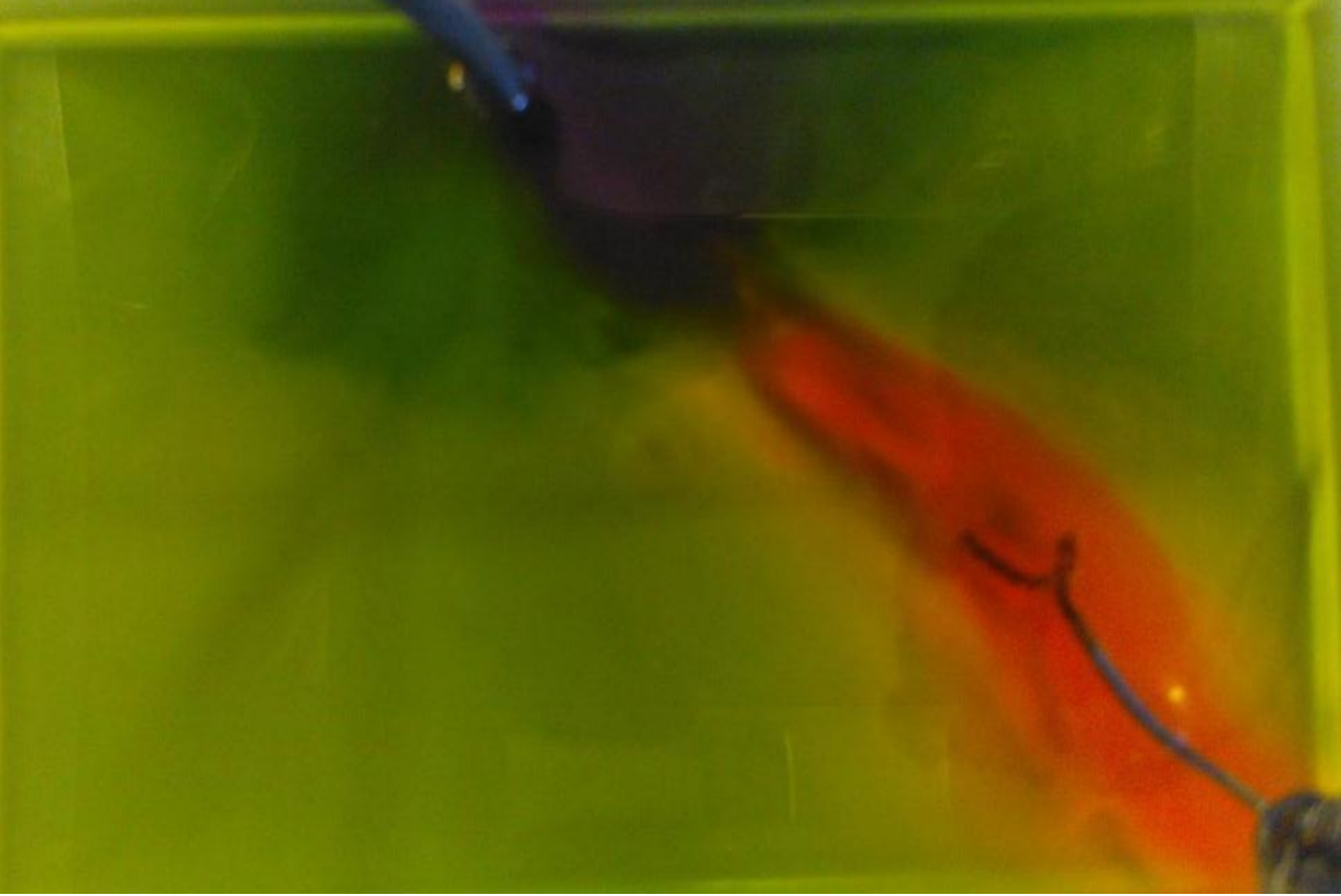
- Sweep meter around, record lowest reading
- Hilti Ferroscan
  - Logs as it goes
  - Large amounts of data can be used to indicate bar sizes, spacing and variability
  - Has its limits

STRUCTURAL CONCRETE ALLIANCE
ASSET PROTECTION & REPAIR

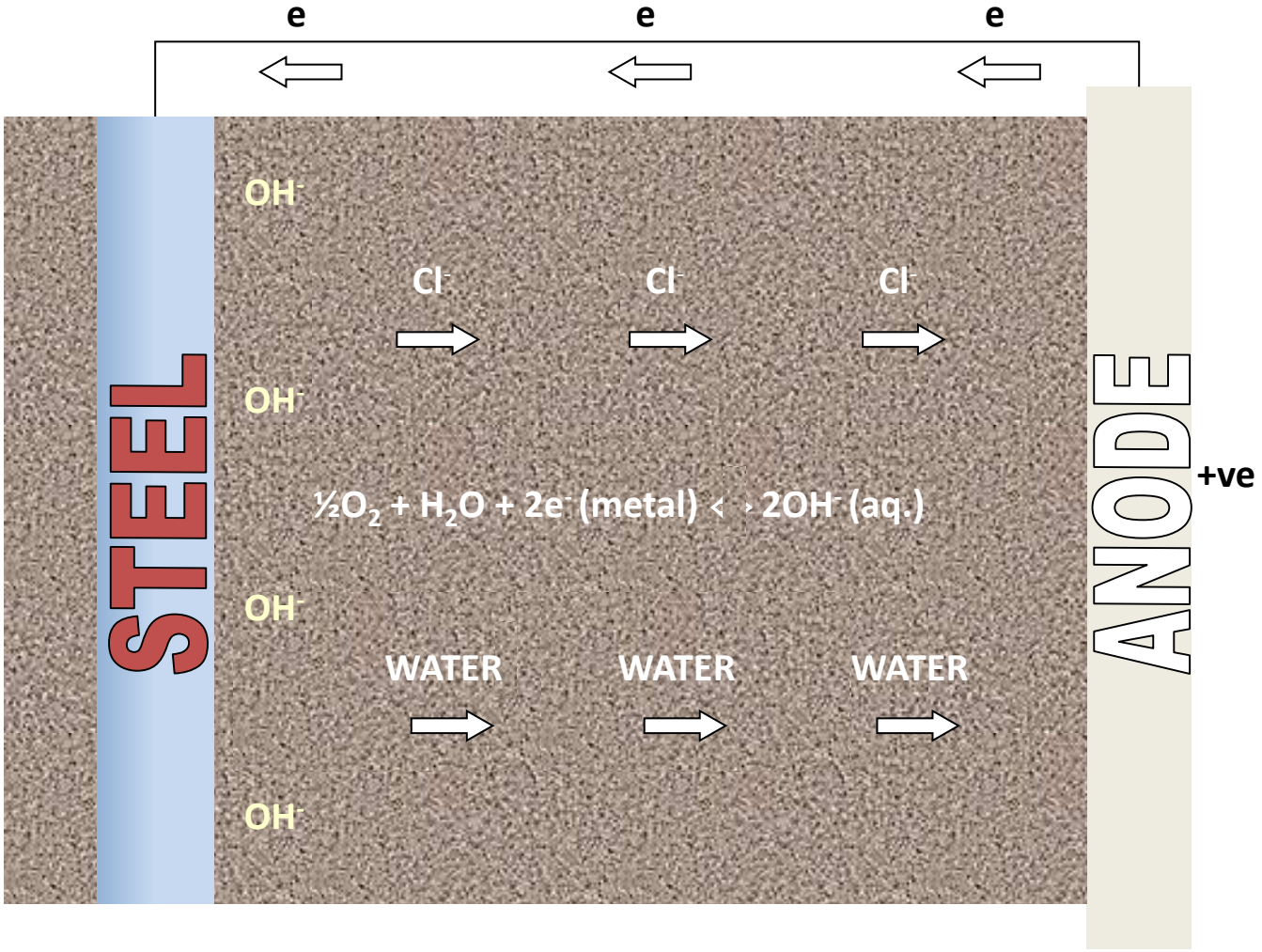
The voice of the concrete repair and refurbishment industry

The Structural Concrete Alliance brings together the expertise of:

CONCRETE REPAIR ASSOCIATION
cpa
SCA



Cathodic Protection



Documents

- BS EN ISO 12696 2012 - CP of concrete
  - Includes criteria, first published in 2000
- BS EN 15257 2006 – Certification of CP people
- BA 83 – Highways Agency Advice Note
- TR 73 – Concrete Society Guidance

Hydrogen Embrittlement

- BS EN 12696:
  - -720mV vs Silver / Silver Chloride / 0.5M Potassium Chloride
- Or
  - 100mV Decay in 24 hours
- Or
  - 150mV decay over longer periods
- AND
- No potentials more negative than -900mV for prestressed concrete

STRUCTURAL CONCRETE ALLIANCE
ASSET PROTECTION & REPAIR

The voice of the concrete repair and refurbishment industry

The Structural Concrete Alliance brings together the expertise of:

CONCRETE REPAIR ASSOCIATION

cpa

SCA

Hydrogen Embrittlement

- If steel is >600MPa UTS
- AND
  - Is under high stress
- AND
  - Is susceptible to it
- AND
  - Hydrogen is being generated
- Risk of hydrogen embrittlement

Hydrogen Embrittlement

- Most cases are self corrosion in very high strength steels
- Simple to avoid in most reinforced concrete
  - Don’t turn the system up that high
- We rarely achieve the -720mV
- All the systems I have designed, commissioned or monitored have never come close to -900mV
- Use Galvanics if you’re not sure

Summary

- Steel rusts
- Inspection needs care
- For chloride induced corrosion CP saves
  - Carbon Dioxide
  - Repairs
  - Access
  - Propping
- Codes are available
  - Competence of personnel
  - Safe Operation of Systems

£

Chris.atkins@mottmac.com