Continuous Galvanized Rebar

SEBPP Charleston, WV

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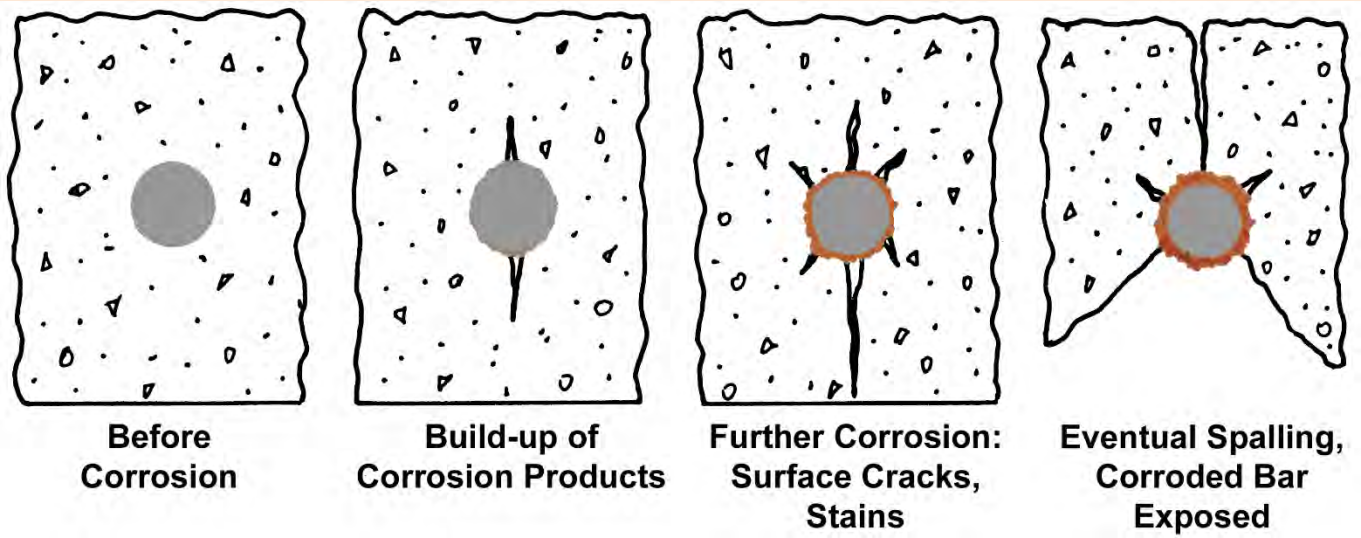
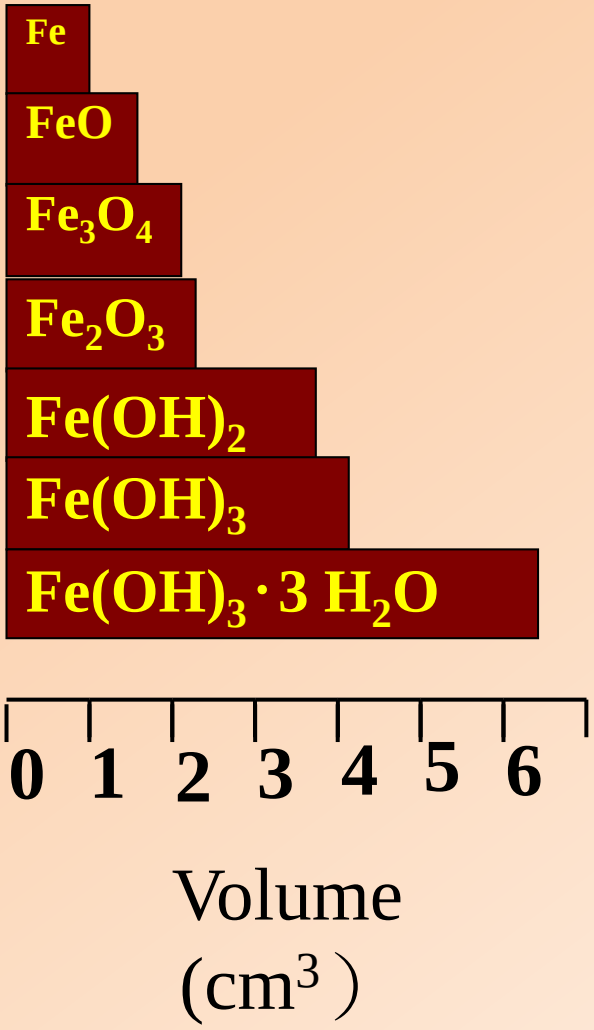
In concrete, steel corrosion can cause major deterioration



Corrosive elements - water, air, chlorides, CO_2 - diffuse through the concrete matrix to reach rebar

Damage from Corrosion of Bare Rebar



Longevity Case Study

Athens Bridge

ATHENS, PA • 1973

Jesup Bridge

Jesup County, Iowa • 2013

Autoroute 40 Reconstruction

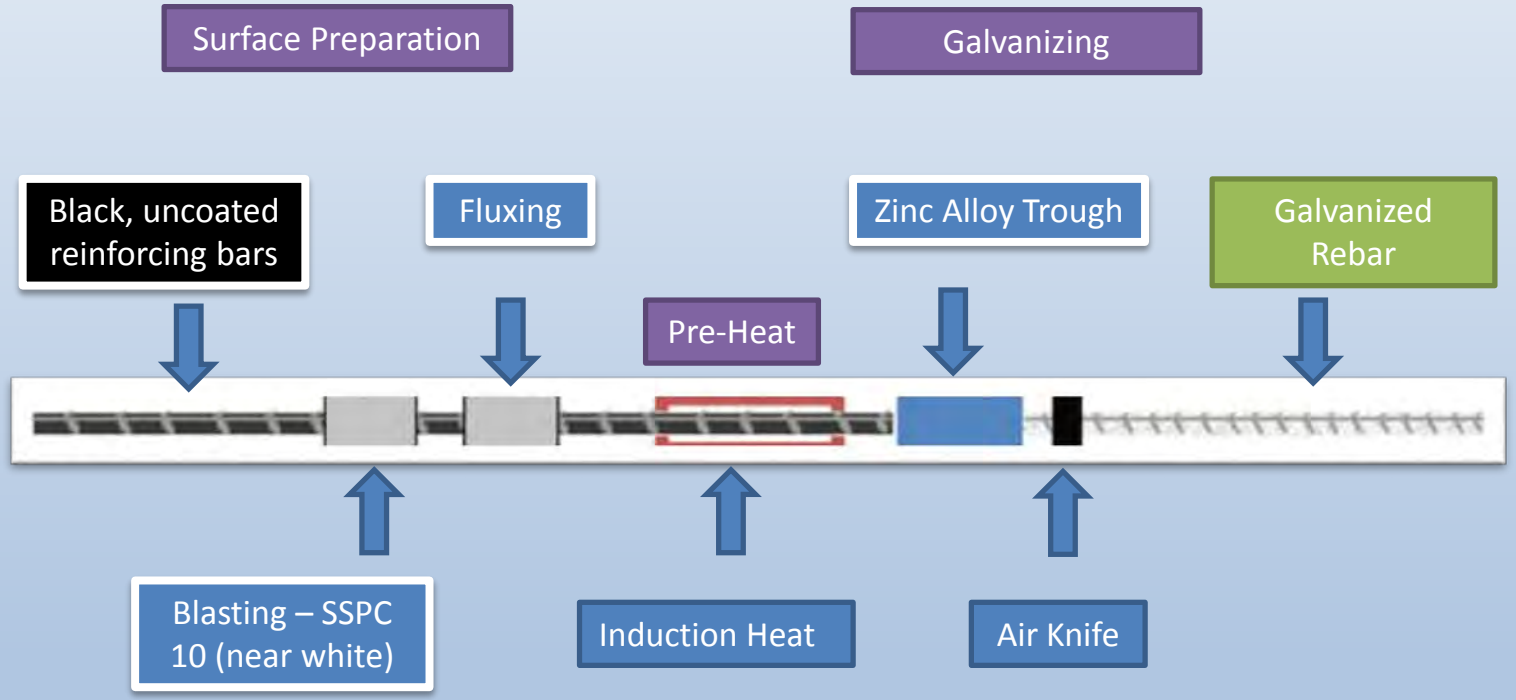
MONTREAL, QC • 2014

National Bridge Inventory

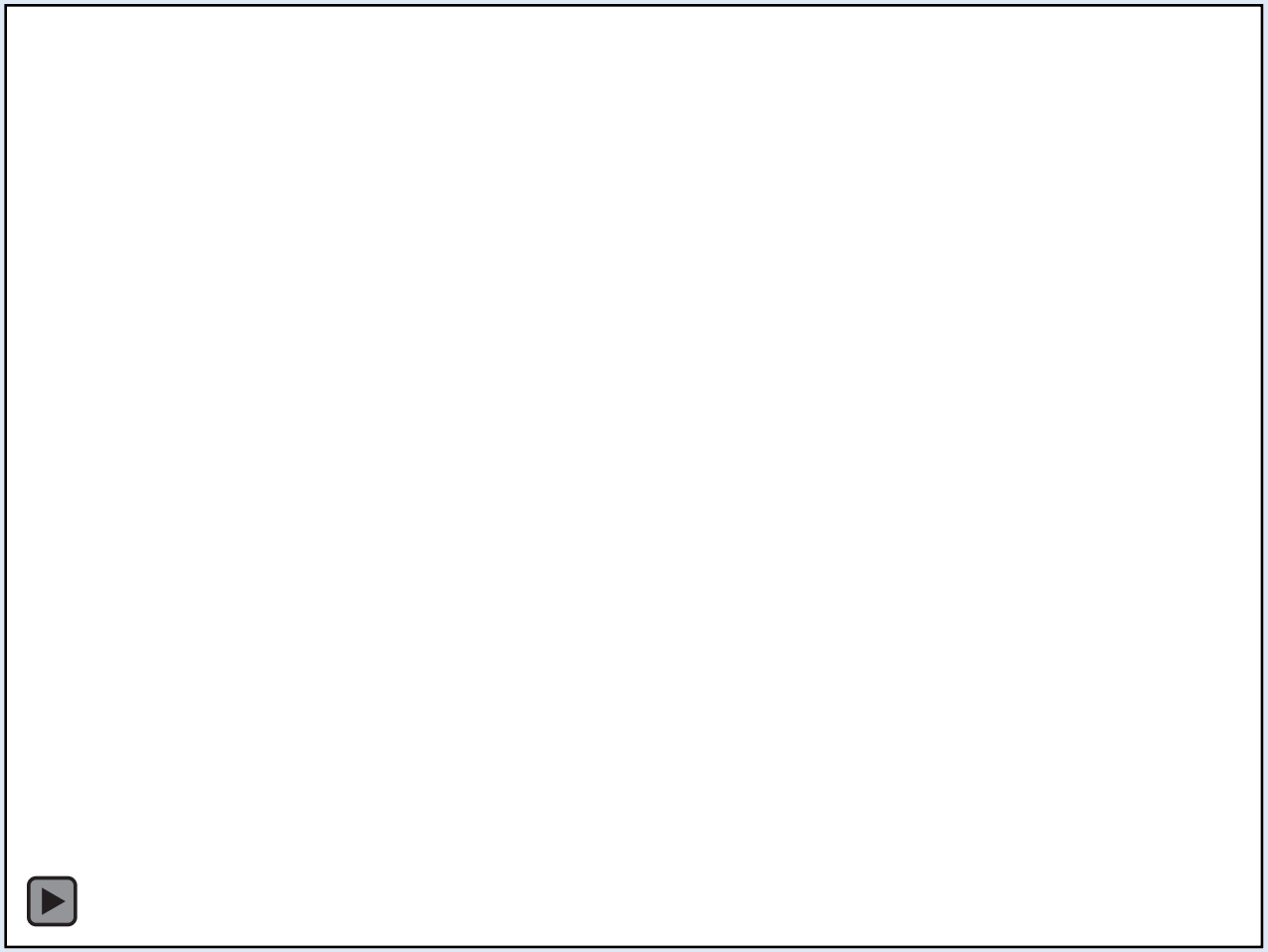
- Over 611,000 Bridges
- 337,051+ have no protection
- **87,601 have epoxy coated reinforcement**
  - 386 with other coated reinforcement
- 1,226 are Galvanized
  - 41 states
- 794 are Polymer
- 322 Cathodic Protection
- Less than 15% Corrosion resistant reinforcement

What is Continuous Galvanized Rebar

CGR Process


Surface Preparation
Galvanizing
Black, uncoated reinforcing bars
Fluxing
Zinc Alloy Trough
Galvanized Rebar
Pre-Heat
Blasting – SSPC 10 (near white)
Induction Heat
Air Knife

GalvaBar Process Video



Coating Thickness

- 50um (2 mil) thick pure zinc coating
- Equivalent corrosion protection to thicker Zn-Fe alloy layers
- Faster passivation, slower corrosion rate

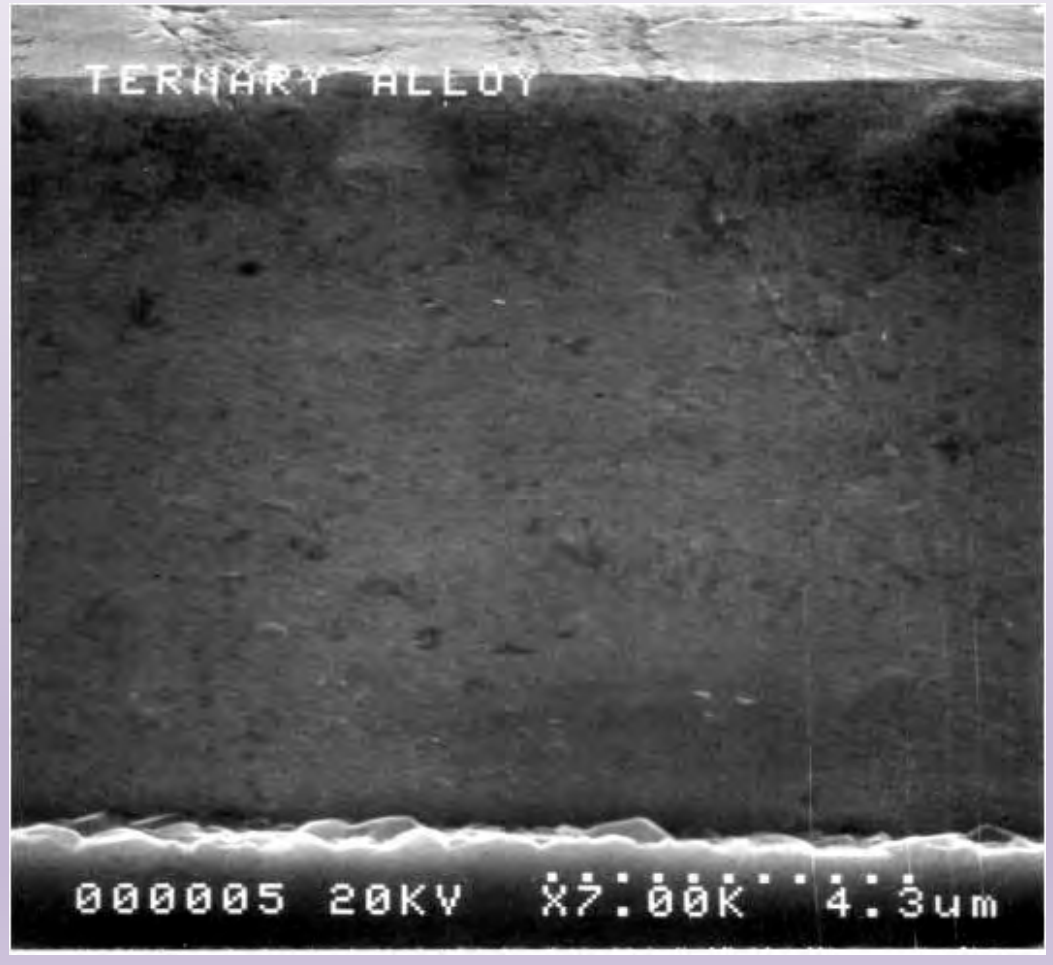
Coating Type	Average depth loss to passivation (um)
Annealed	1.18
Pure Zinc	0.45

Tan & Hansson, Corrosion Science

Photomicrograph

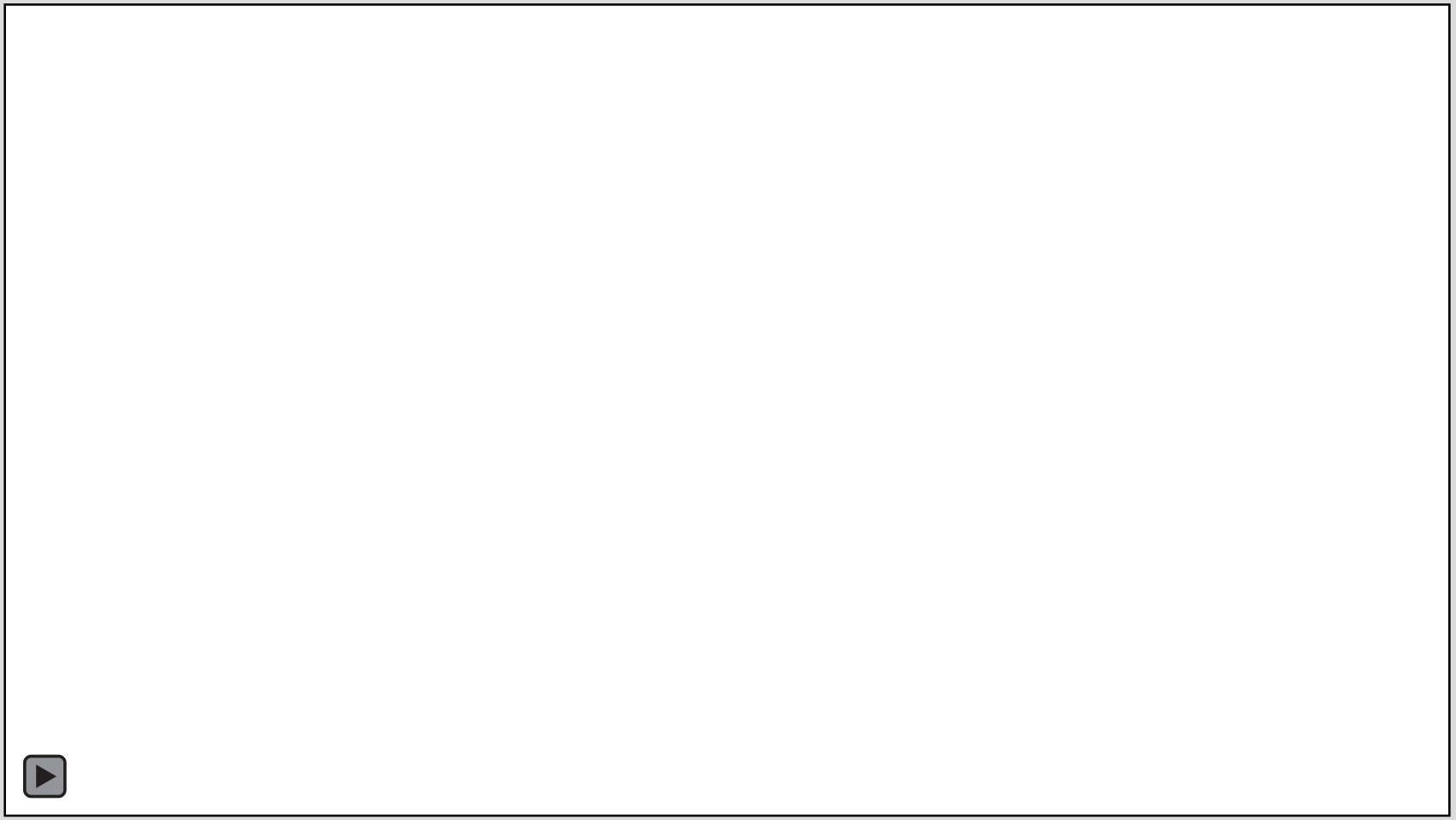
Zinc (η) Layer ®

Ternary
$Fe_2Al_{5-X}Zn_X$ Layer ®



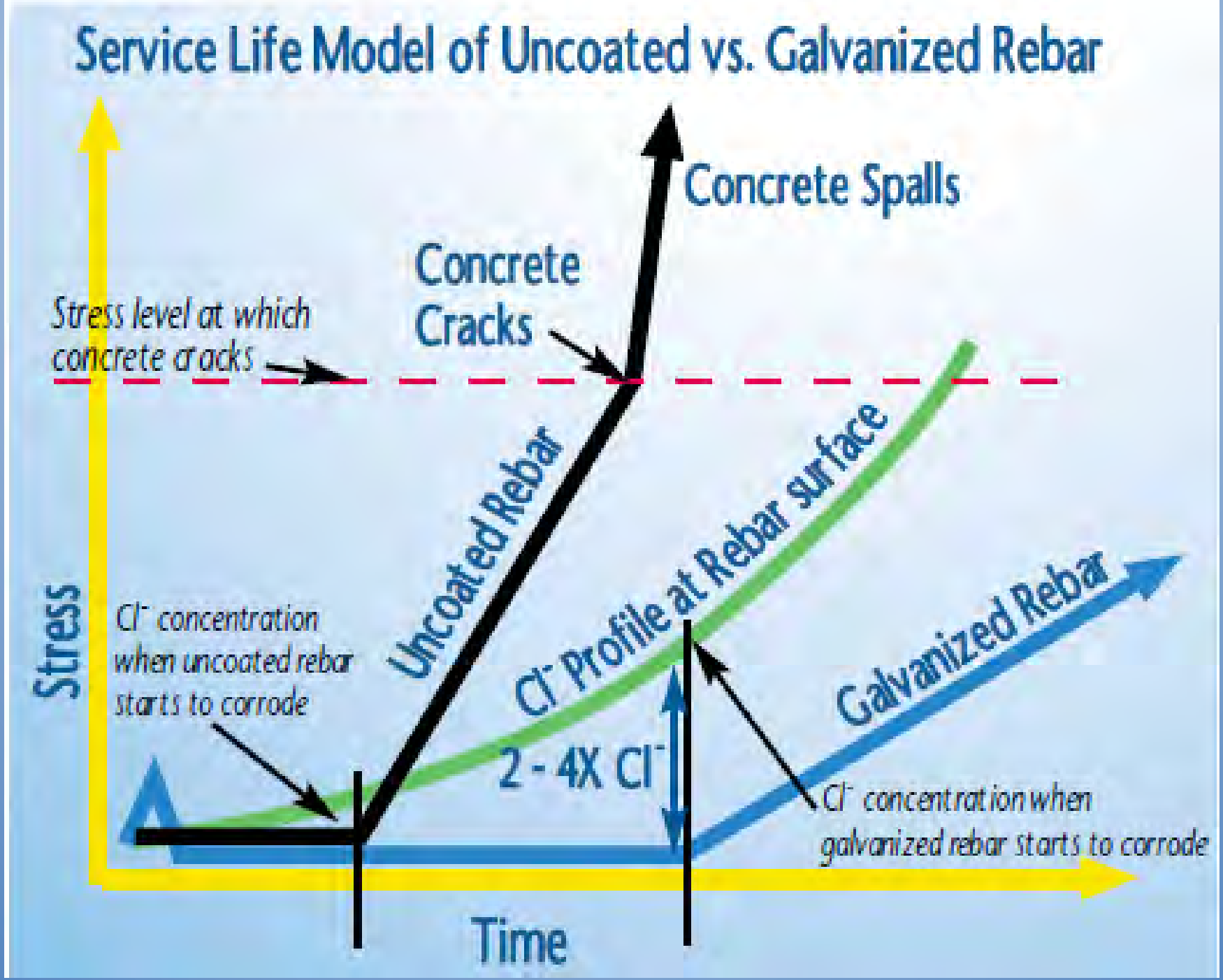
Is CGR formable?

Formability



How CGR protects rebar

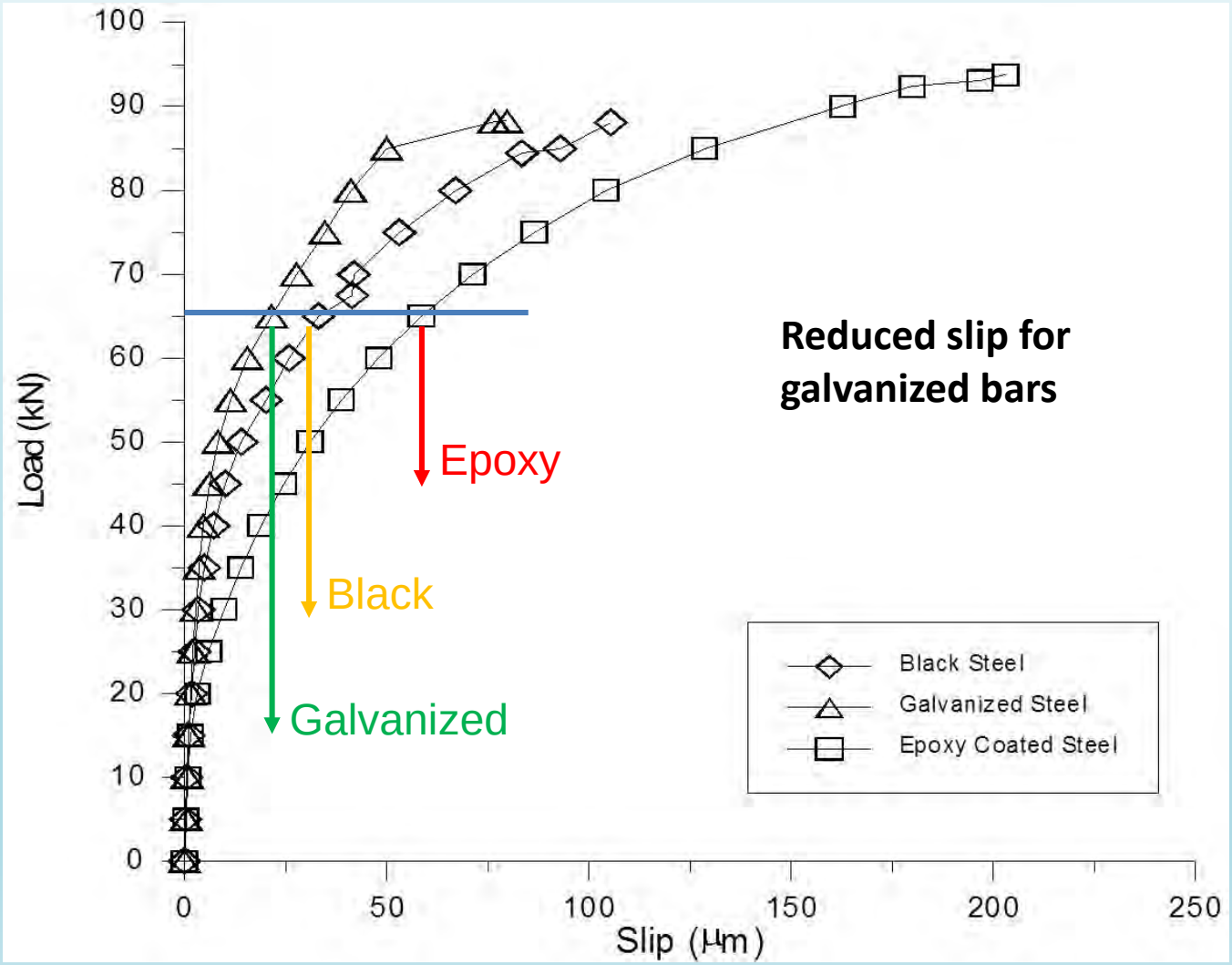
- Protective Reaction Product (CaHZn)
- High Chloride Threshold (2 - 4X black steel)
- Low pH Tolerance (Carbonation)
- Corrosion Product Migration
  - Concrete Matrix Densification
  - Lower Unit Stress Generation
  - Good bond strength
- Barrier coating (Metallurgical Bond) w/Cathodic Protection


Service Life Model of Uncoated vs. Galvanized Rebar
Concrete Spalls
Concrete Cracks
Stress level at which concrete cracks
Uncoated Rebar
Cl⁻ Profile at Rebar surface
Galvanized Rebar
Stress
Cl⁻ concentration when uncoated rebar starts to corrode
2 - 4X Cl⁻
Cl⁻ concentration when galvanized rebar starts to corrode
Time

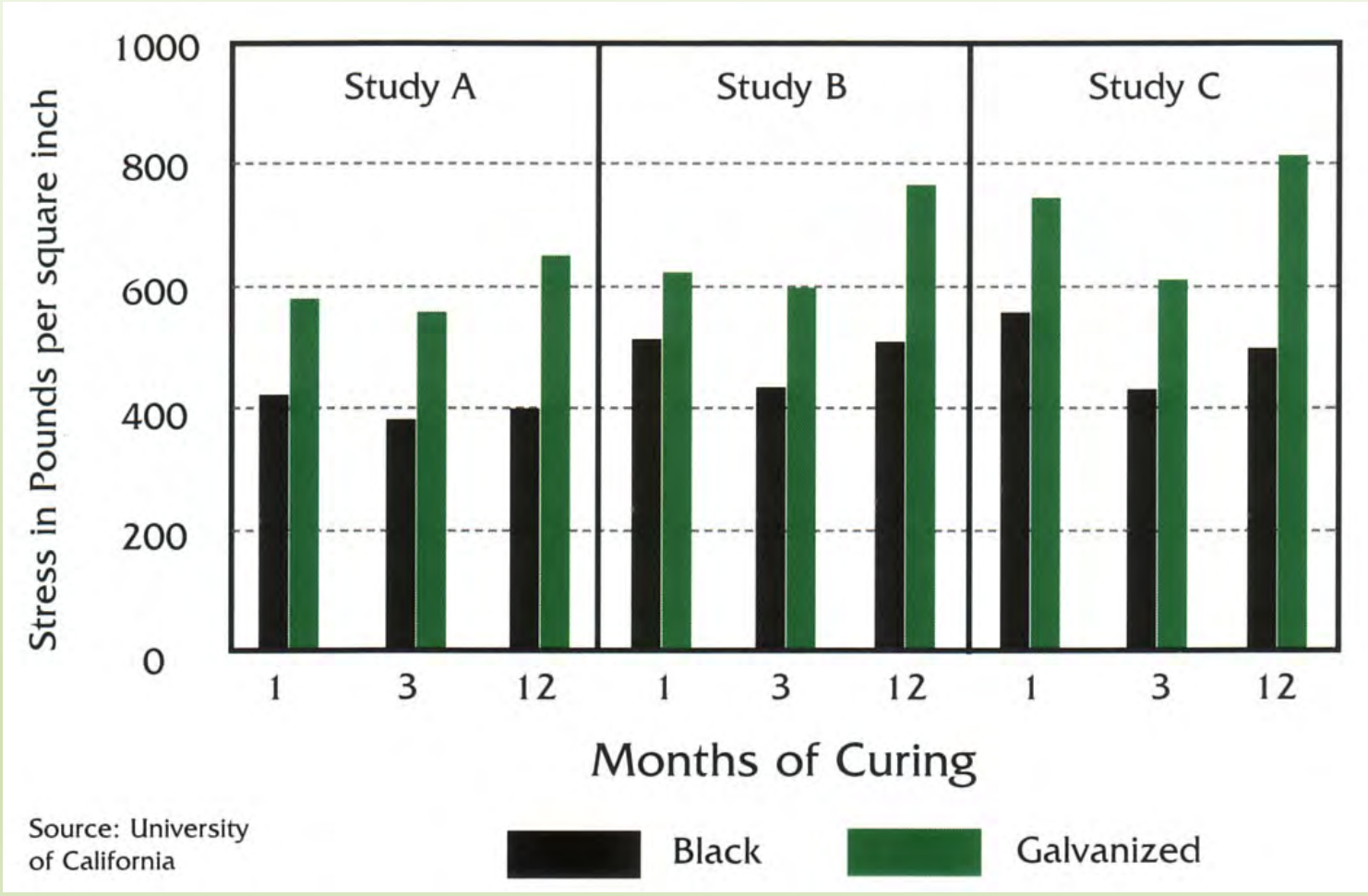
Zinc passivates in wet alkaline concrete

- Zinc in strongly alkaline solutions (> pH 12.5) is passivated by formation of layer of adherent crystals - calcium hydroxyzincate (CaHZn).
- Reaction commences immediately on contact with wet cement solution.
- The surface film stabilizes the zinc, isolating it from surrounding environment.
- The reaction with zinc ceases once the concrete hardens.

Load-Slip Characteristics



Bond Strength



Guidelines for Rebar Corrosion (mV vs CSE)

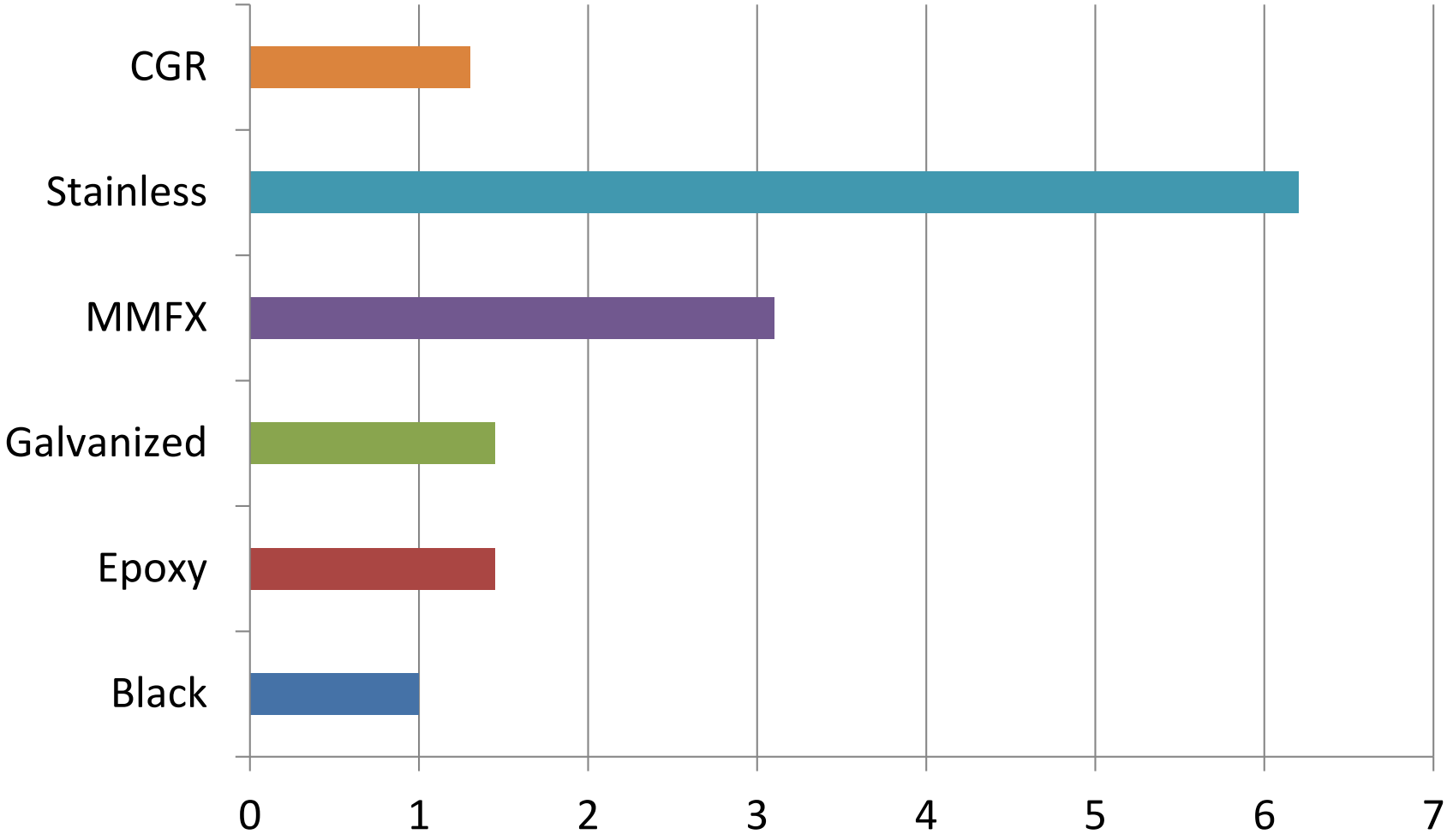
ASTM C876 For Steel (mV vs CSE)	Probability of corrosion	NRC For Zinc (mV vs CSE)
> -200	Low 10% probability	> -335
-200 to -350	Uncertain	-335 to -500
< -350	High 90% probability for steel 85% probability for zinc	< -500

NRC report A339, 2015

Installation

- Same as Black rebar:
- Same overlap links
- Same handling procedures
- No weather restrictions
- No sensitivity to UV light
- No touchup (except field-cut ends)
- Use galvanized or plastic connectors (where permissible)

Rebar Product Comparison



ASTM Specifications

Designation: A1094/A1094M

Standard Specification for
Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement[1]

Designation: A1055/A1055M

Standard Specification for
Zinc and Epoxy Dual-Coated Steel Reinforcing Bars

CGR Location #1

Stadium Bridge Canton City Parks
Canton, Ohio

Port of Catoosa, OK


Thank You