2013 Bridge Preservation Partnership

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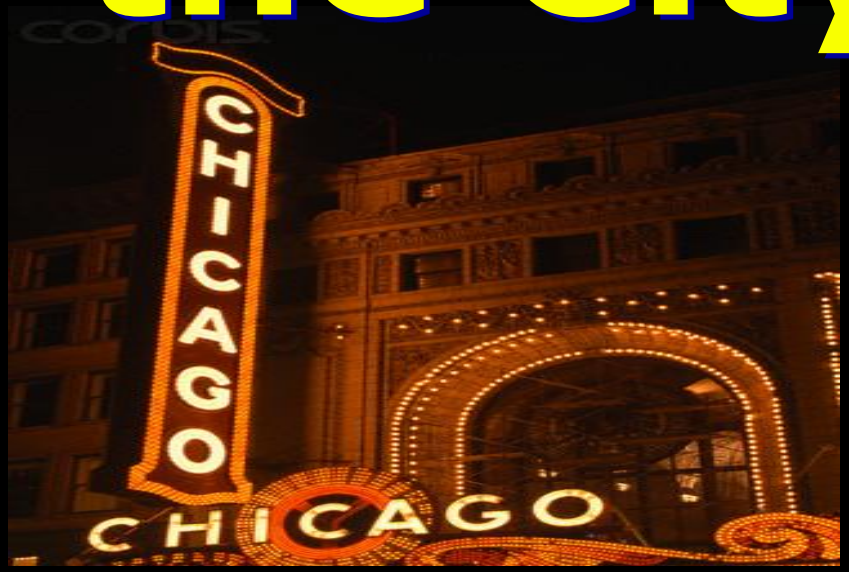
The Corrosion Problem

Tour of the City

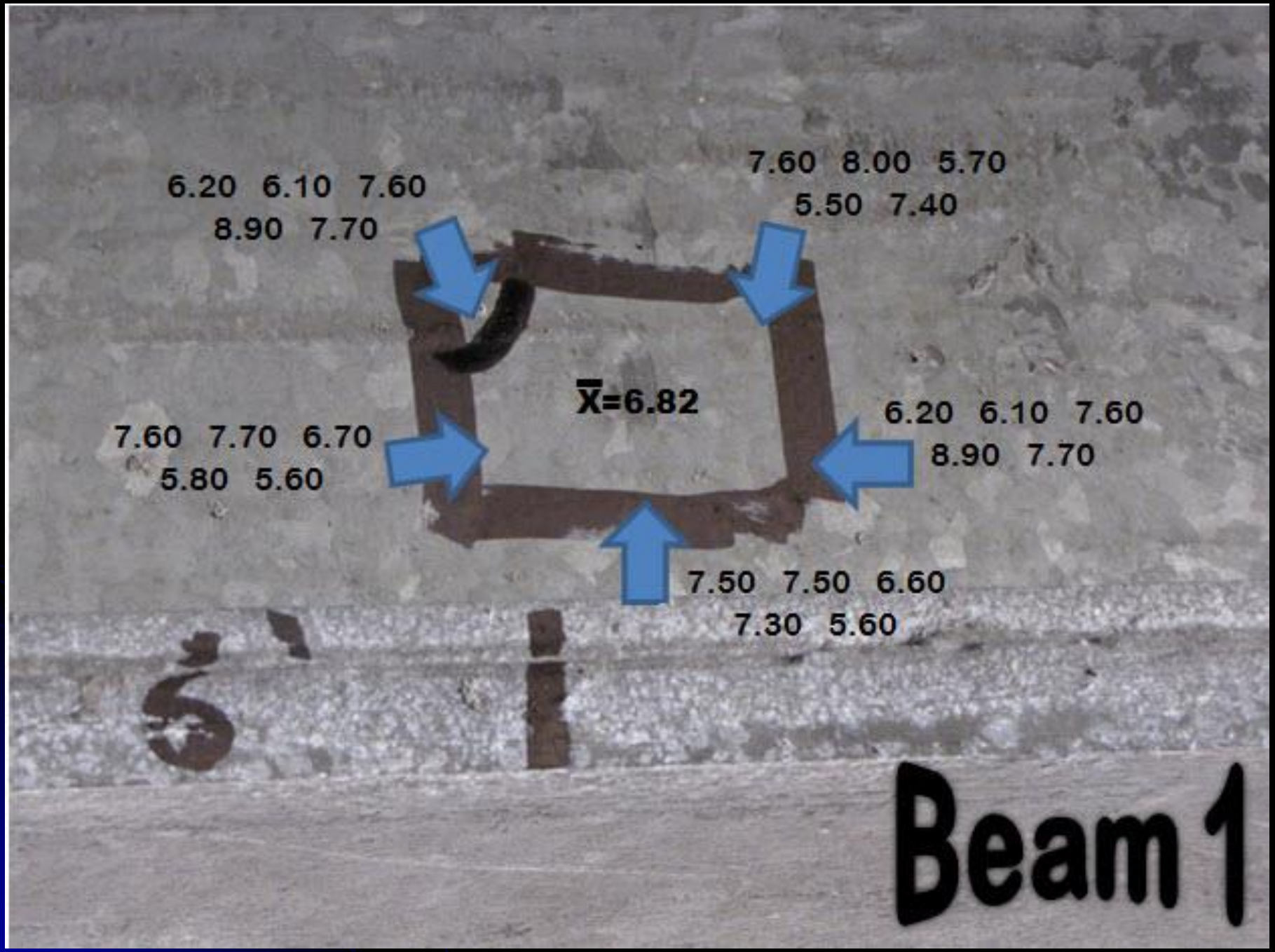



Clark Ave
1
nois Ave.
1 3/4


got rust?*

Corrosion Protection

I-69 Bridge


6.20 6.10 7.60
8.90 7.70
7.60 8.00 5.70
5.50 7.40
$\bar{X}$=6.82
7.60 7.70 6.70
5.80 5.60
6.20 6.10 7.60
8.90 7.70
7.50 7.50 6.60
7.30 5.60
Beam 1

Ford County – 00N, 2350E

New Galvanized Bridges in Chicago

- 35th Street & Dan Ryan 362 Tons
- 51th Street & Dan Ryan 349 Tons
- Douglas Lake Connection 1444 Tons
- 57th Street & Dan Ryan 346 Tons
- 67th Street & Dan Ryan 403 Tons
- Michigan Ave over I-94 234 Tons
- 91st Street & Dan Ryan 234 Tons
- 26th Street & Dan Ryan 194 Tons

26th Street & the Dan Ryan

CTA, IL Toll Road, IDOT & County Engineers

Have GALVANIZED more than 60,000 lbs of bridge beams.

Tappen Zee Bridge

Tappen Zee Bridge

Michigan/MI-102 Bridge Rail

Date Galvanized
2007

Components Galvanized
Guide rails

Environment
Urban

Location
Detroit, MI


Michigan/M-102 Bridge - Detroit, MI

Michigan / MI-102 Bridge Rai


Richland County Bridge
13FT-2IN

The Corrosion Problem

25-30% could be eliminated if adequate corrosion protection systems were employed

Corrosion Problem - Infrastructure

$1.6 trillion investment necessary to maintain America's infrastructure

27% of the nation's bridges are structurally deficient or functionally obsolete

Poor road conditions cost motorists $54 billion a year in repairs and operating costs

The Solution

Long-Lasting Zinc Protection

- Barrier
- Cathodic
- Zinc Patina
- Metallurgical Bond

Barrier Protection

Cathodic Protection

Galvanic Series of Metals

ZINC = ANODE

STEEL = CATHODE

This arrangement of metals determines what metal will be the anode and cathode when the two are put in a electrolytic cell (arrangement dependent on salt water as electrolyte).

Sacrificial Zinc Anodes

Zinc Patina

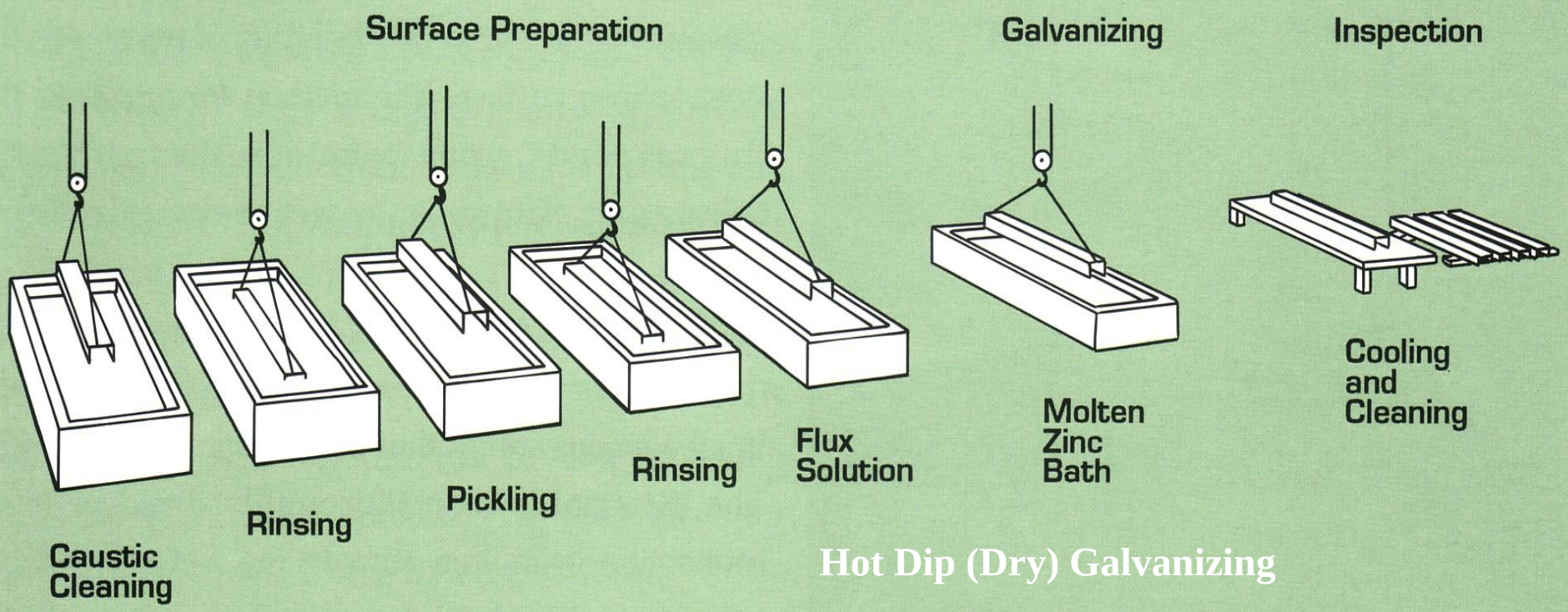
Zinc Carbonate

Zinc Hydroxide

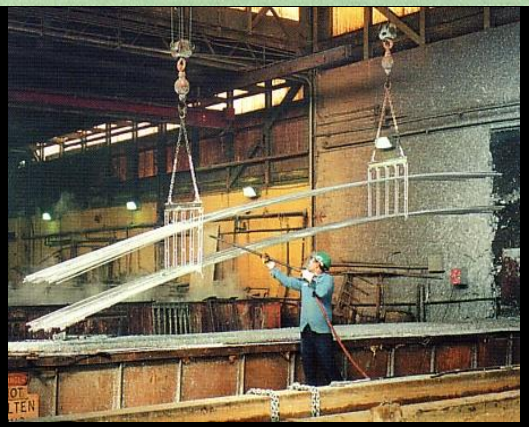
Zinc Oxide

Zinc

Galvanizing Process



Hot Dip (Dry) Galvanizing



HDG Process: Galvanizing

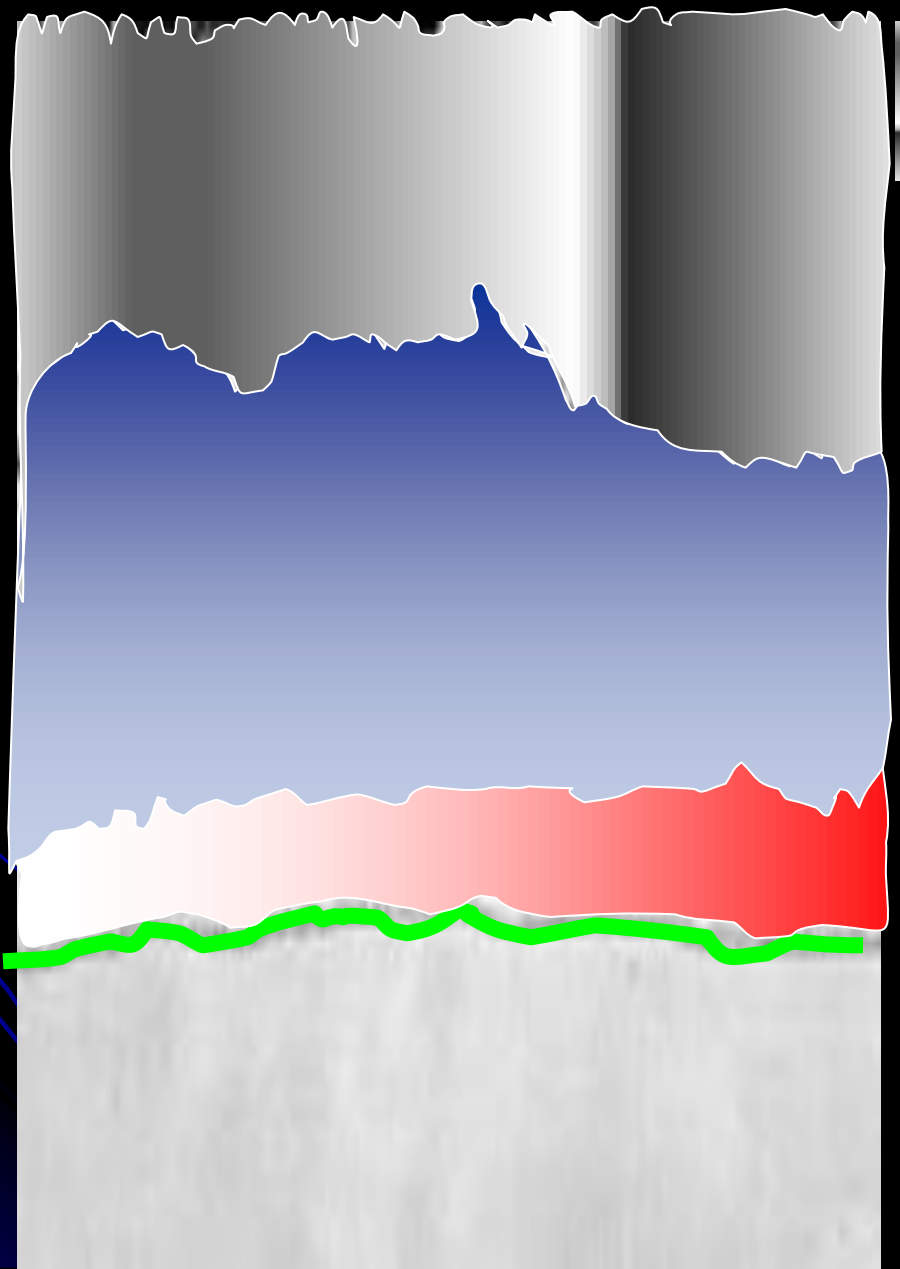
Galvanizing Bath

- Steel immersed in bath of molten zinc (~830 F)
- > 98% pure zinc, up to 2% additives (Al, Bi, Ni)
- Zinc reacts with iron in steel to form coating
- Reaction is complete when steel reaches bath temperature

HDG Process: Inspection

- Steel is inspected after galvanizing to verify conformance to specs
- Visual inspection to identify any surface defects
- Magnetic thickness gauge to check coating thickness

Metallurgical Bond



Eta

Zeta

Delta

Gamma

100% Zinc

94% Zinc
6% Iron

90% Zinc
10% Iron

75% Zinc
25% Iron

Abrasion Resistance

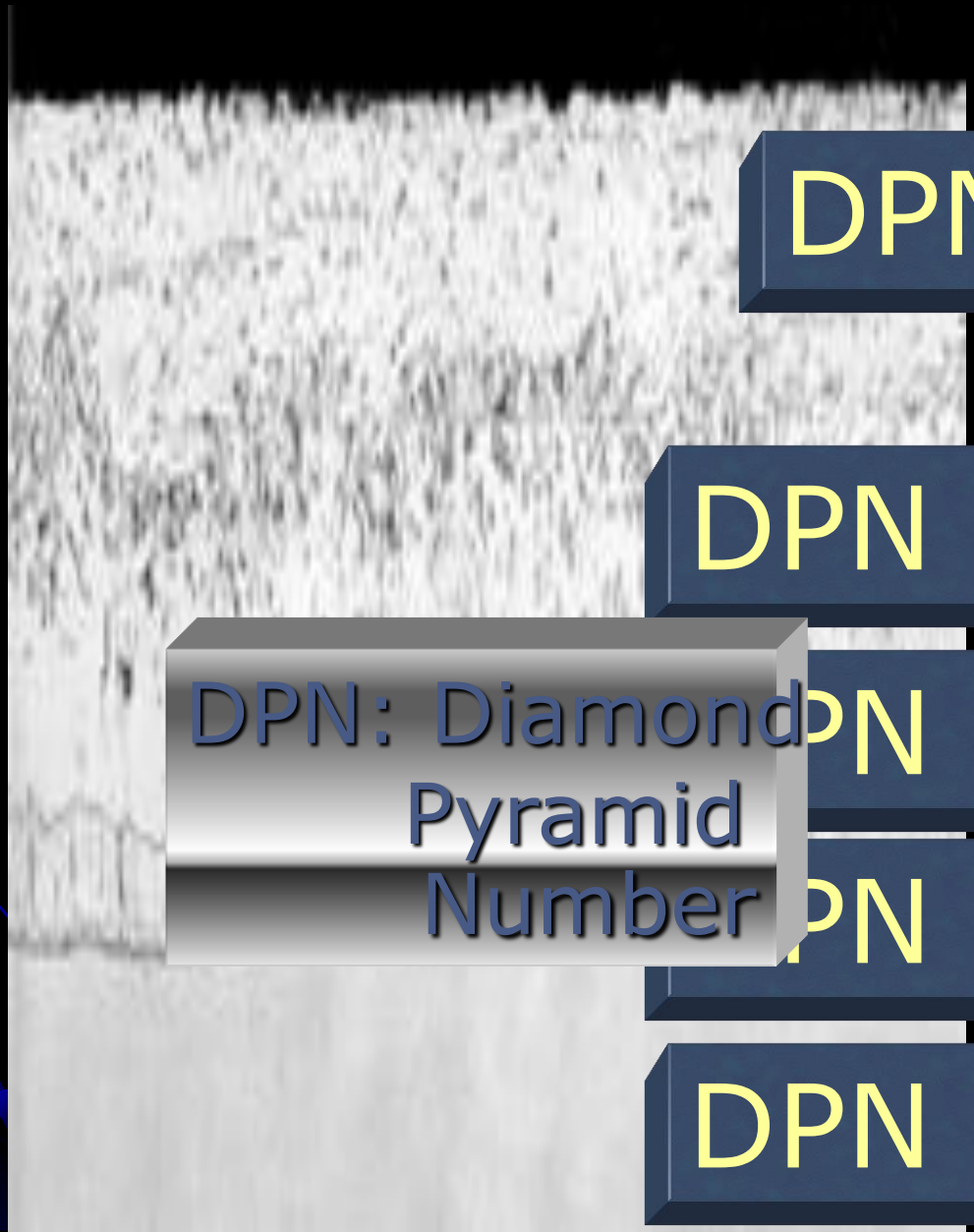
Eta

Zeta

Delta

Gamma

Steel



DPN =70

DPN = 180

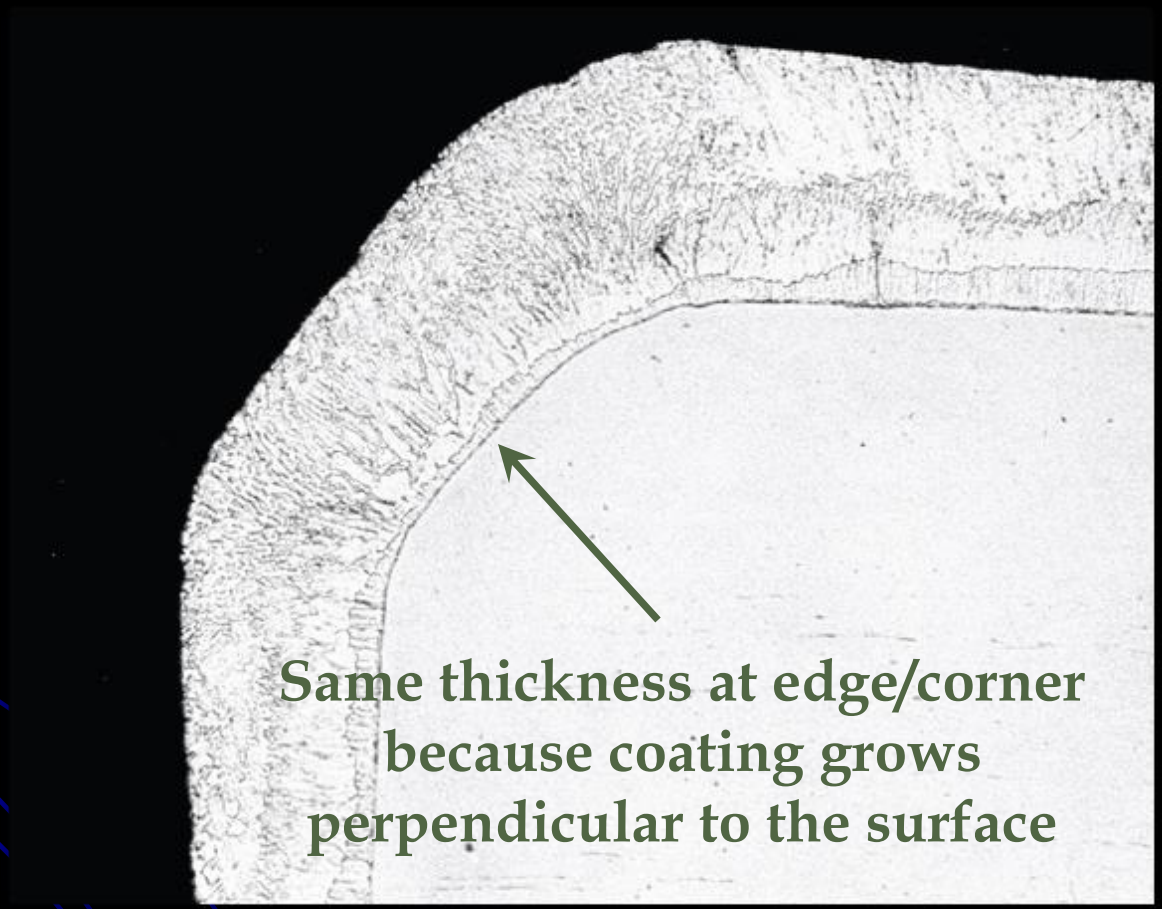
DPN = 245

DPN = 250

DPN = 159

DPN: Diamond Pyramid Number

Edge Protection



Variety of Sizes & Shapes

Availability

It’s Recyclable

Sustainability: Galvanizing is Green

- Zinc and steel are 100% recyclable
  - Properties of zinc (and steel) do not degrade with reprocessing
  - Zinc is a natural element in the Earth's crust
  - Recycled content contributes to LEED
- Galvanizing's maintenance-free durability ensures no additional energy, materials, or emissions during use

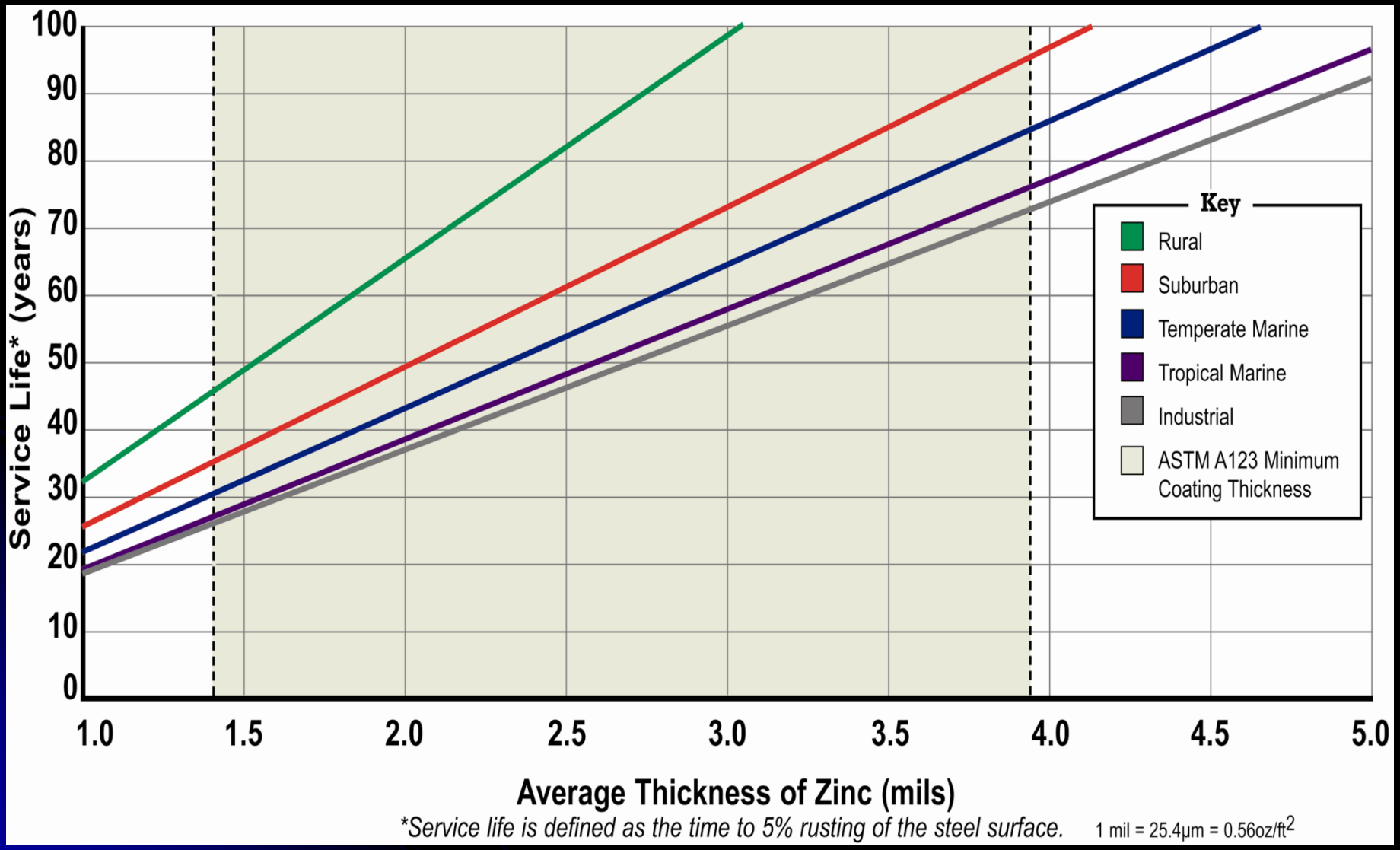
Hot-Dip Galvanizing & LEED®

- HDG contributes points under *Materials & Resources Credit 4: Recycled Content*
  - Credit 4.1: Use materials with recycled content (10%)
    - sum of post consumer recycled content plus one-half of the pre-consumer content equals 10% of the total value of the materials in the project
  - Credit 4.2: Use materials with recycled content (20%)
    - sum of the post consumer recycled content plus one-half of the pre-consumer content constitutes at least an additional 10% beyond Credit 4.1 (total of at least 20%) of the total value of the materials in the project

Zinc Coating Life Predictor

- Anticipates time to first maintenance for galvanized coatings
  - Worldwide corrosion database
- Atmospheric categories
  - Rural
  - Suburban
  - Temperate Marine
  - Tropical Marine
  - Industrial
- Estimates corrosion rate based on
  - Temperature
  - Airborne salinity
  - Sulfur dioxide concentration
  - Relative humidity
  - Rainfall
  - Sheltering condition

Estimated Service Life of HDG



Other Zinc Coatings

Metallized

Hot-Dip Galvanized

ized

t

lectroplated

1 mil

Galvanizing Oversized Pieces

- Average kettle length is 40 feet (North America)
- Many kettles 50-60 feet
- Progressive dipping used for larger pieces
- Communicate with galvanizer during design process


09.19.2006


26th Street & the Dan Ryan

Specifications & Inspection

Galvanizing Specifications

- ASTM A 123 – iron and steel products
  - Minimum coating thicknesses, finish, adherence
- ASTM A 153 – iron and steel hardware
  - Items centrifuged or spun to remove excess zinc
  - Minimum coating thickness, finish, adherence
- ASTM A 767 – steel bars for concrete
  - **NO** bare spots, free from sharp tears or spikes
  - Bend diameters and coating thickness

ASTM D 6386

- *Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products and Hardware Surfaces for Painting*
- Covers the proper methods of surface preparation to remove contaminants from the galvanized surface without removing zinc

Galvanized Steel Bridges


Stears Bayou Bridge

Stearns Bayou Bridge

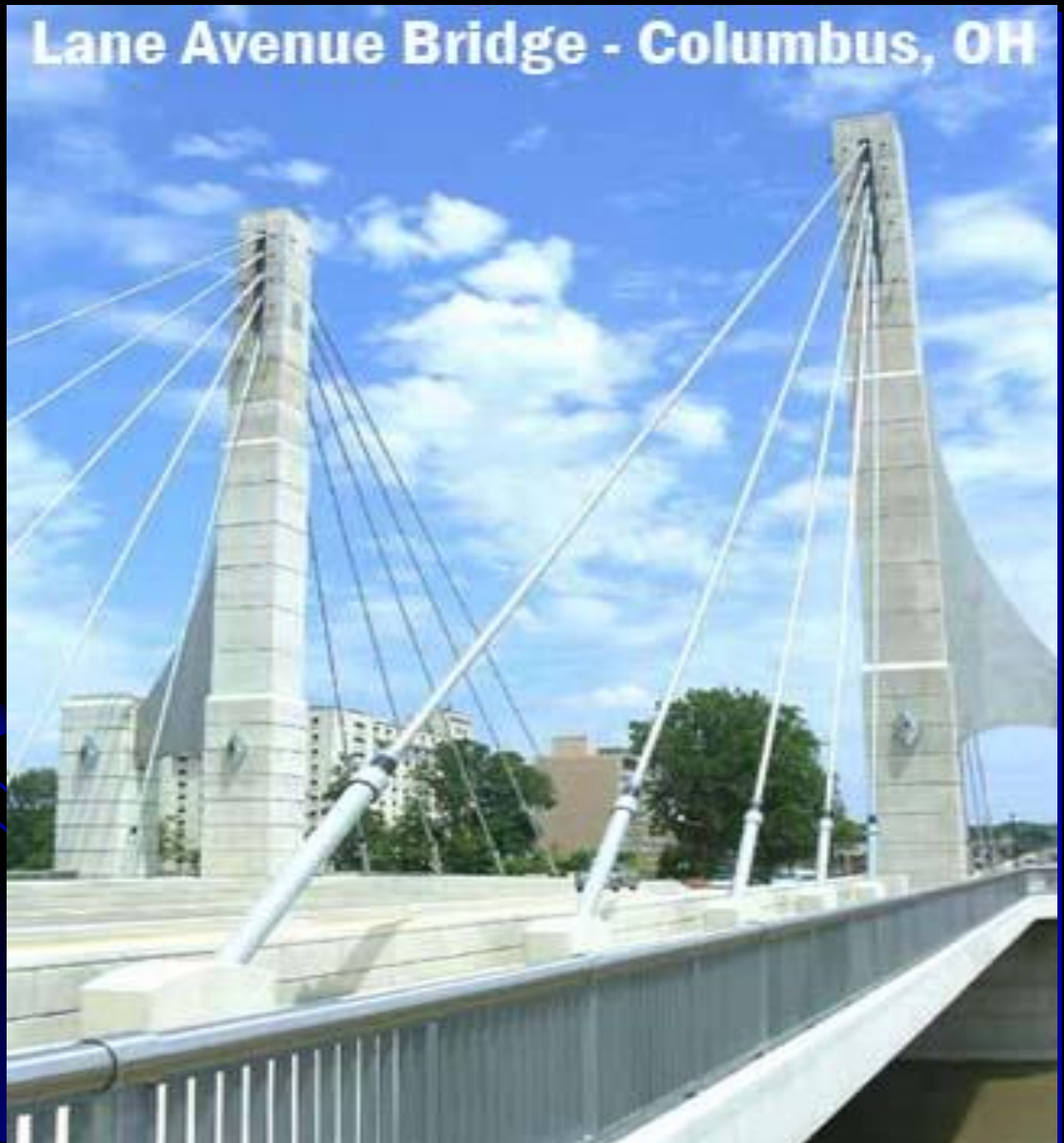

Stearns Bayou Bridge

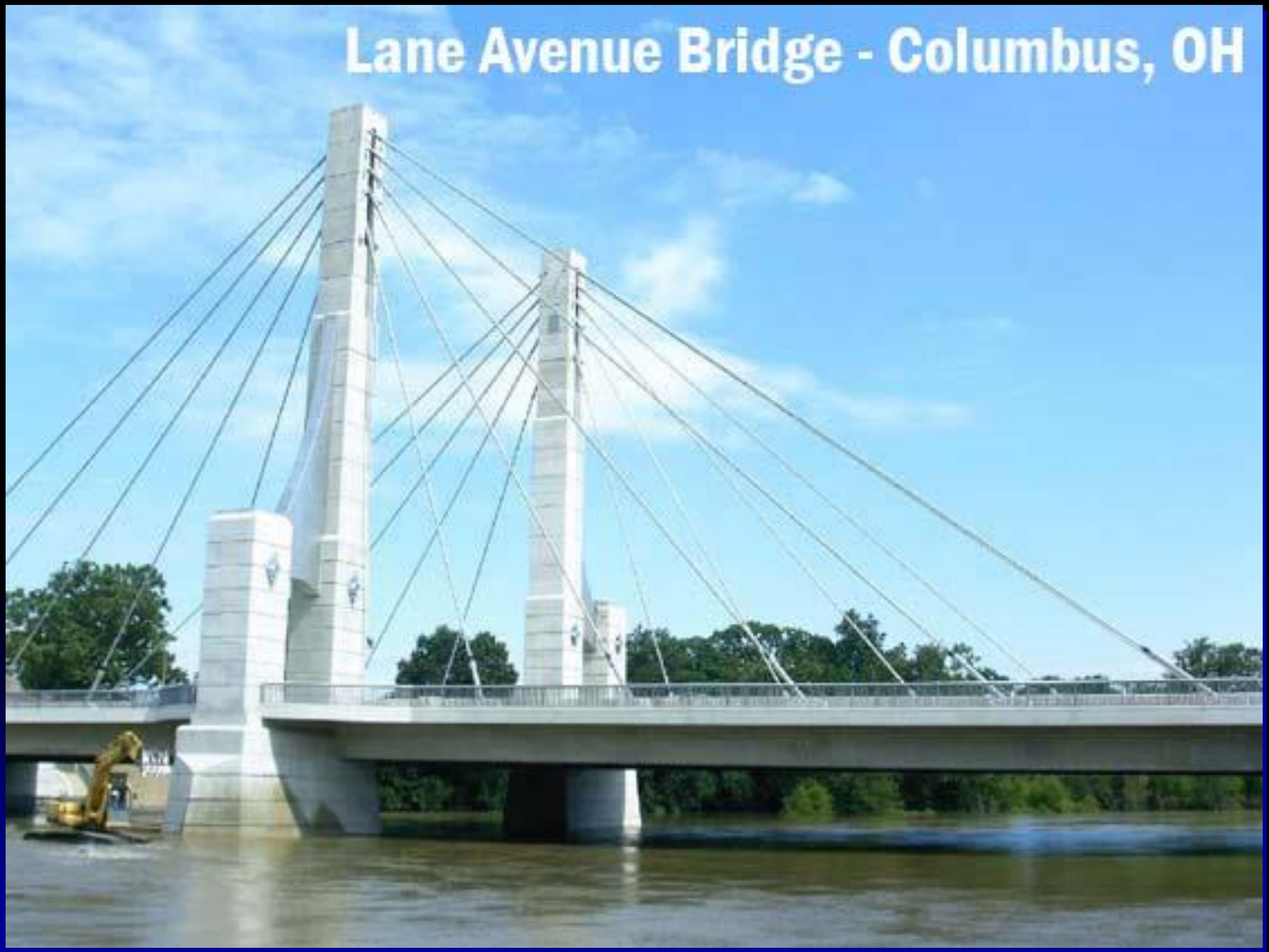
Sterns Bayou Bridge


F20H
Fischer
µm/s
mils
2.94
Thickness
n= 96
DEL
ON/OFF


Spring Lake Bridge MI

Dick Vale Bridge Peru, ME


Lane Avenue Bridge - Columbus, OH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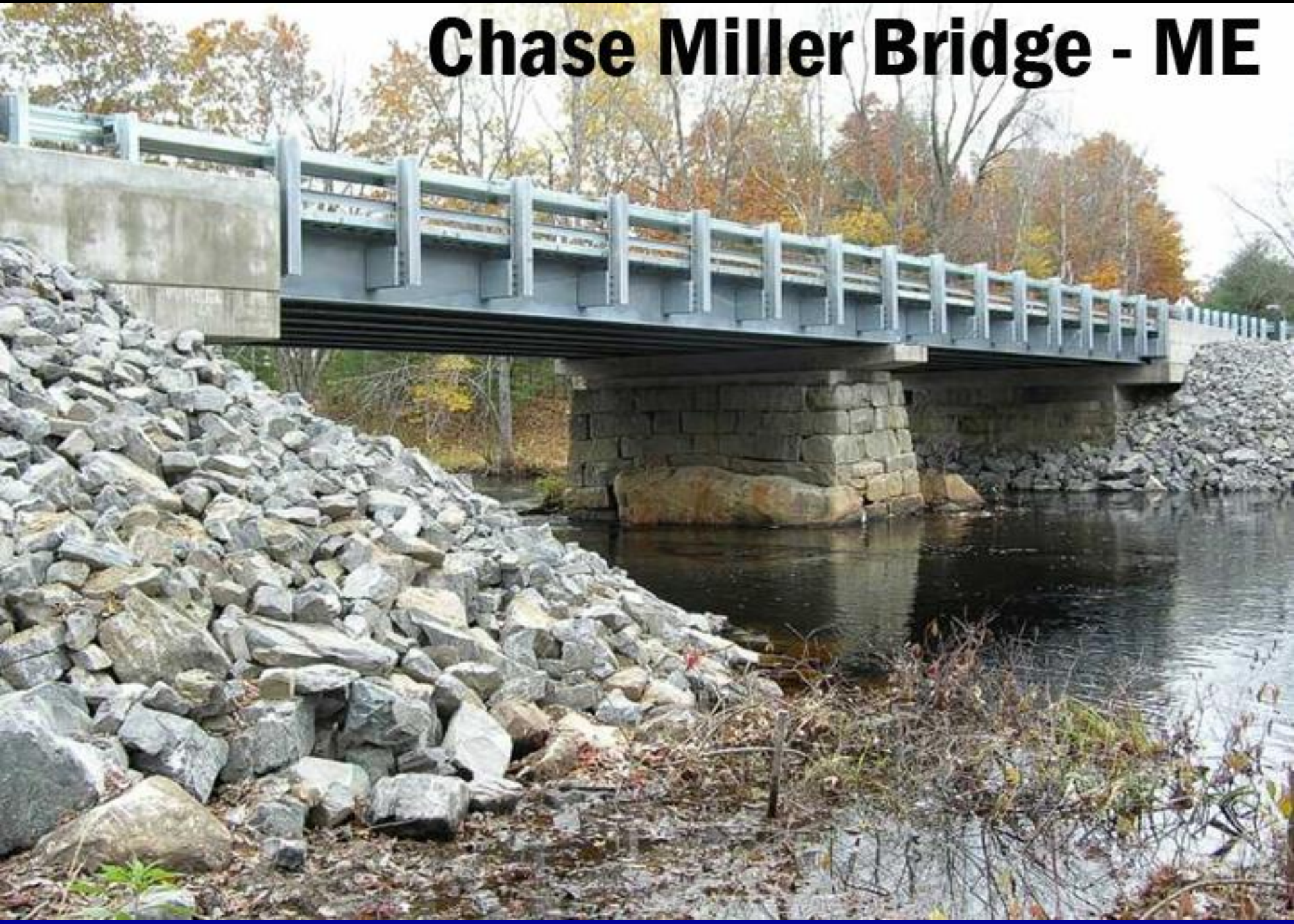
Chase Miller Bridge - ME


Fallowfield Township – Washington County


Bryants Bridge – Saratoga County N. Y.

Multi-Span Bridge - Puerto Rico

GalvanizeIt!

Thank You!

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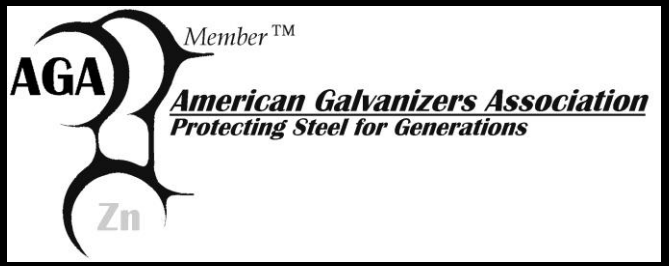

Hot-Dip Galvanizing Costs Less Lasts Longer

The Cost of Corrosion Protection

- Initial cost will always factor into decision
- Life-cycle cost analysis is more complete
  - Includes all future maintenance costs
  - Provides total cost of the project over its life
- Life-cycle cost calculation automated online at www.galvanizeit.org/galvanizingcost/

Quantitative Analysis

- Data Sources:
  - Paint – 2008 KTA Tator paper
    - Nationwide survey of the paint industry
    - Presented at NACE 2009
  - Galvanizing – 2008 AGA Industry Survey
- Project Parameters
  - Standard mix of steel (structural, tubing, plate)
  - 30,000 ft^2 project
  - Moderately industrial environment

Initial Cost Parameters

- Paint
  - Material (one- or two-pack product, number of coats, etc)
  - Shop cleaning labor
  - Shop/field application
  - Field labor
- Galvanizing
  - Process is inclusive of all cleaning, material, and labor

Initial Cost

Inorganic Zinc	$1.35	$40,410
Hot-Dip Galvanizing	$1.60	48,000
Inorganic Zinc/Epoxy	$2.16	$64,800
Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat	$2.55	$76,620
Inorganic Zinc Primer/ Epoxy/ Polyurethane Topcoat	$3.17	$94,950

Life-Cycle Cost

- Maintenance costs calculated on a practical maintenance cycle (vs. ideal)
  - Unique to each paint system
  - Manufacturer recommended cycles provided in the KTA Tator paper
- NACE model for NFV and NPV calculations
  - 2% inflation; 4% interest
- 50-year life
- Maintenance repaint at 5% rust

Life-Cycle Cost ($/ft^2) 60-Year Life

Hot-Dip Galvanizing	$1.60
Inorganic Zinc	$5.16
Inorganic Zinc/Epoxy	$8.07
Inorganic Zinc Primer/Epoxy Intermediate/ Polyurethane Topcoat	$10.04
Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat	$14.82

Total Cost of 60-Year Project

Hot-Dip Galvanizing	$48,000
Inorganic Zinc	$154,800
Inorganic Zinc/Epoxy	$242,100
Inorganic Zinc Primer/ Epoxy/ Polyurethane	$301,200
Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat	$444,600

Questions & Comments