

EPOXY-COATED REINFORCING STEEL BARS IN NORTH AMERICA

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INTRODUCTION

Introduction

- Direct cost of corrosion for highway bridges
 - \$8.29 billion (400 billion INR)
- Total bridges
 - 700,000
 - 71,000 structurally deficient



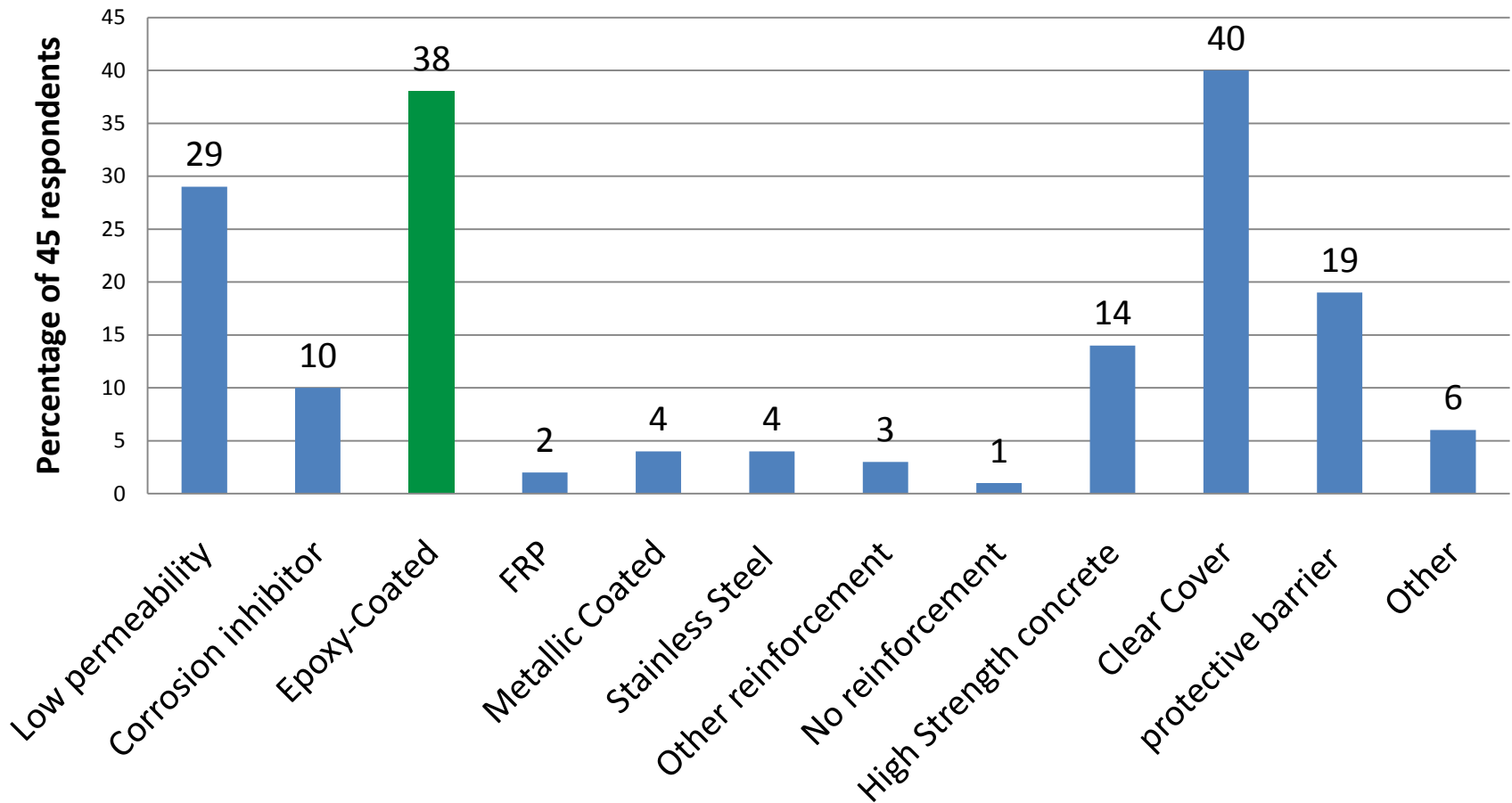
HISTORY

History

- 1950's "clear road" policy
 - Effective snow fighting cuts injury accidents by 88%
- 1970's significant corrosion problem
- 1973 First use of epoxy-coated reinforcing steel



Strategy to prevent corrosion



STANDARD SPECIFICATIONS



Specifications



- ASTM A775/A775M (AASHTO M284)
 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
- AASHTO M254
 - Standard Specification for Corrosion-Resistant Coated Dowel Bars

APPLICATIONS

Use in North America

- 10 percent of all rebar
 - Approximately 600,000 ton/year
- 72 million sq m of ECR (~28 sq mile)
- 65,000 bridges out of 700,000

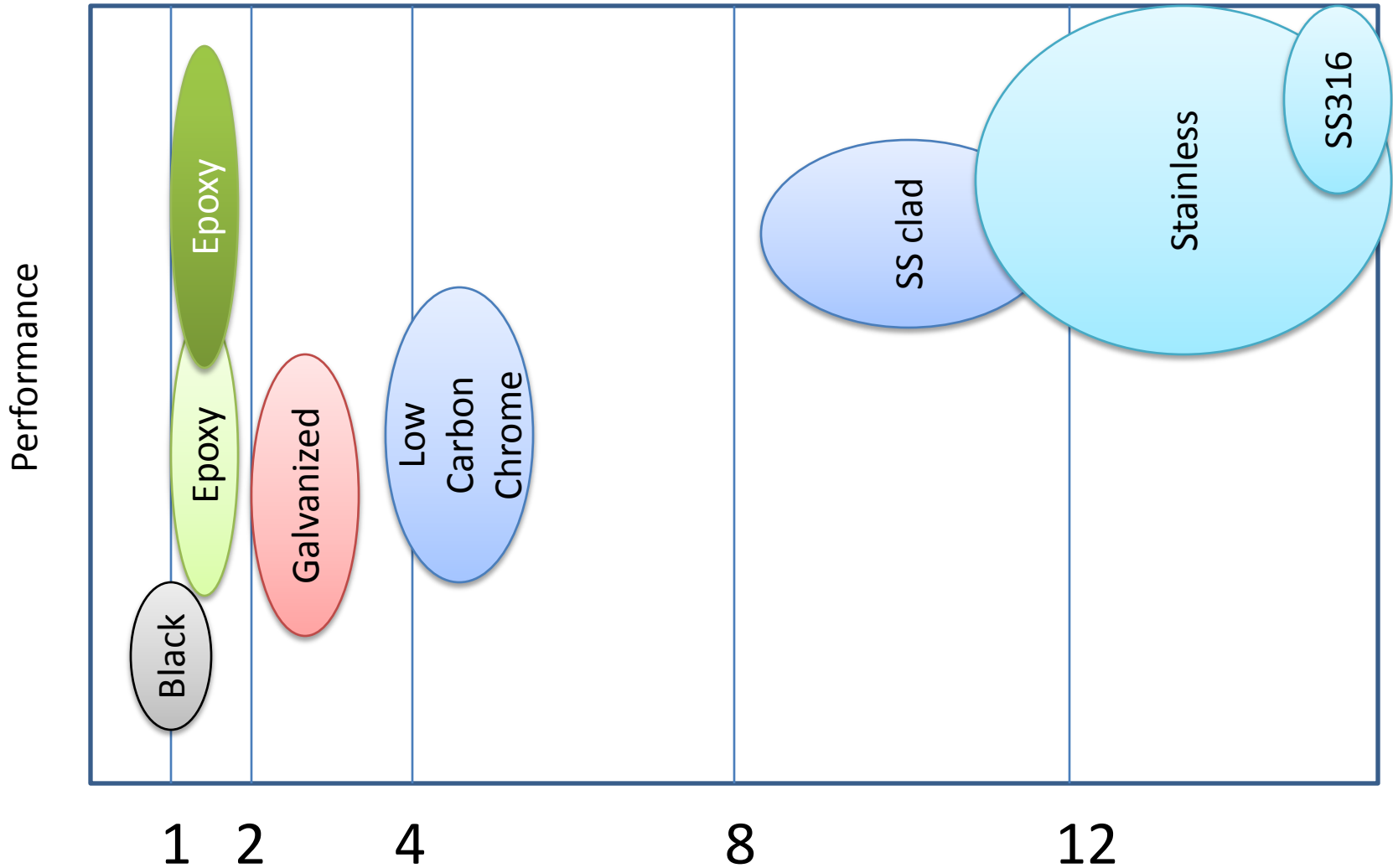


Types of structures

- Bridges
- Parking decks
- Buildings
- Power plants
- Wharfs and other marine
- Water treatment facilities
- Concrete Repair

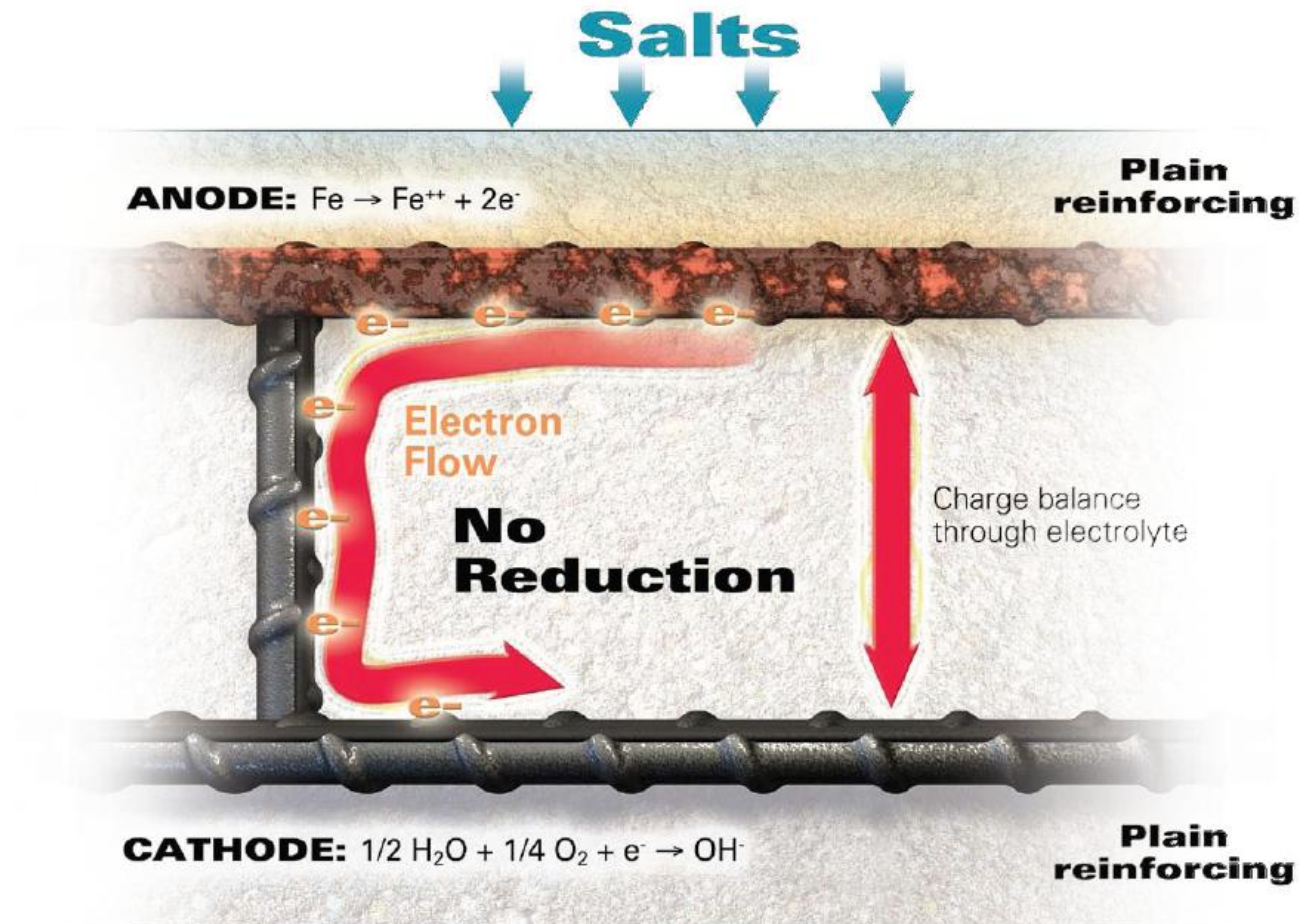


Performance vs. Cost



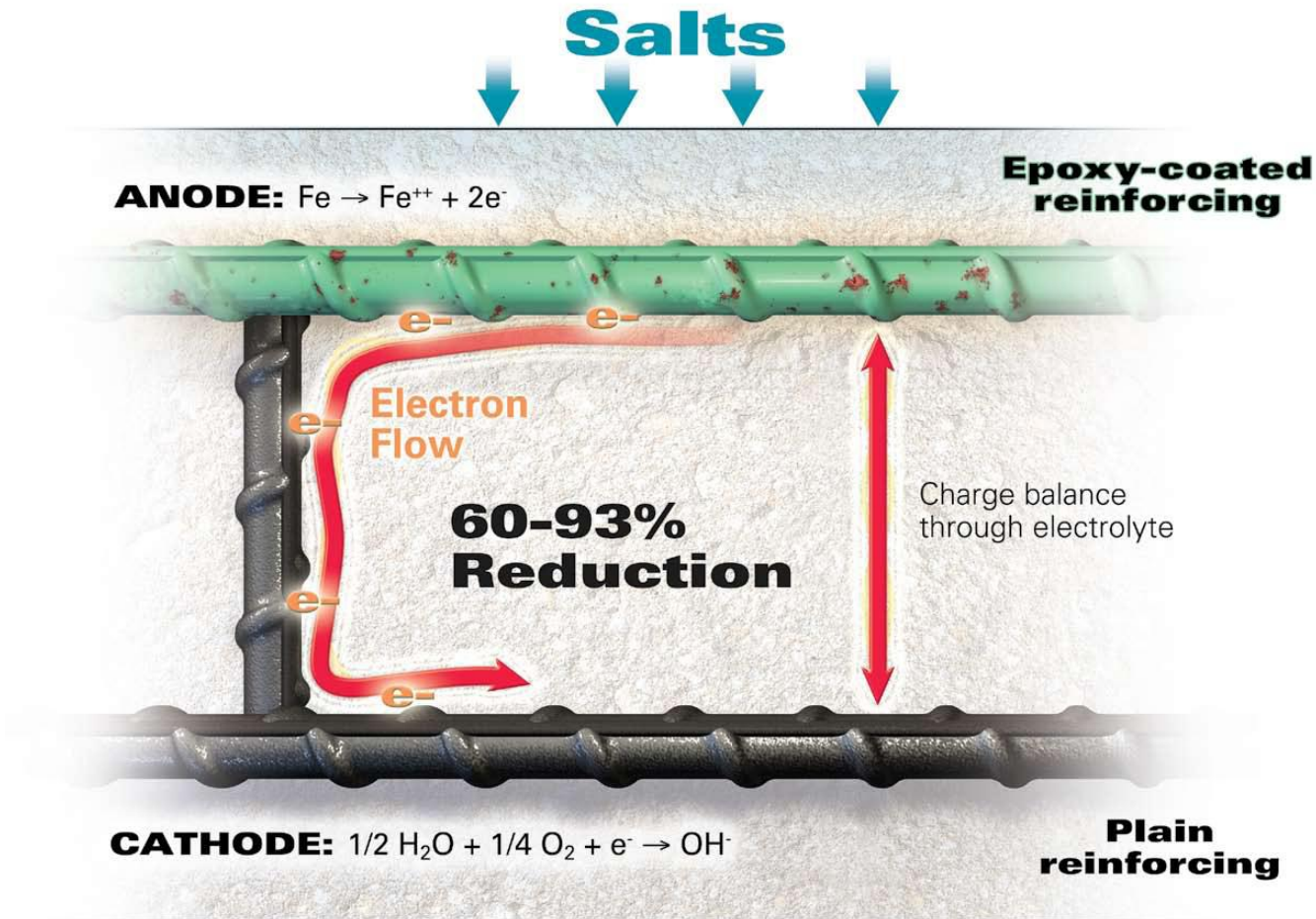
CORROSION PROTECTION MECHANISMS

Black bars



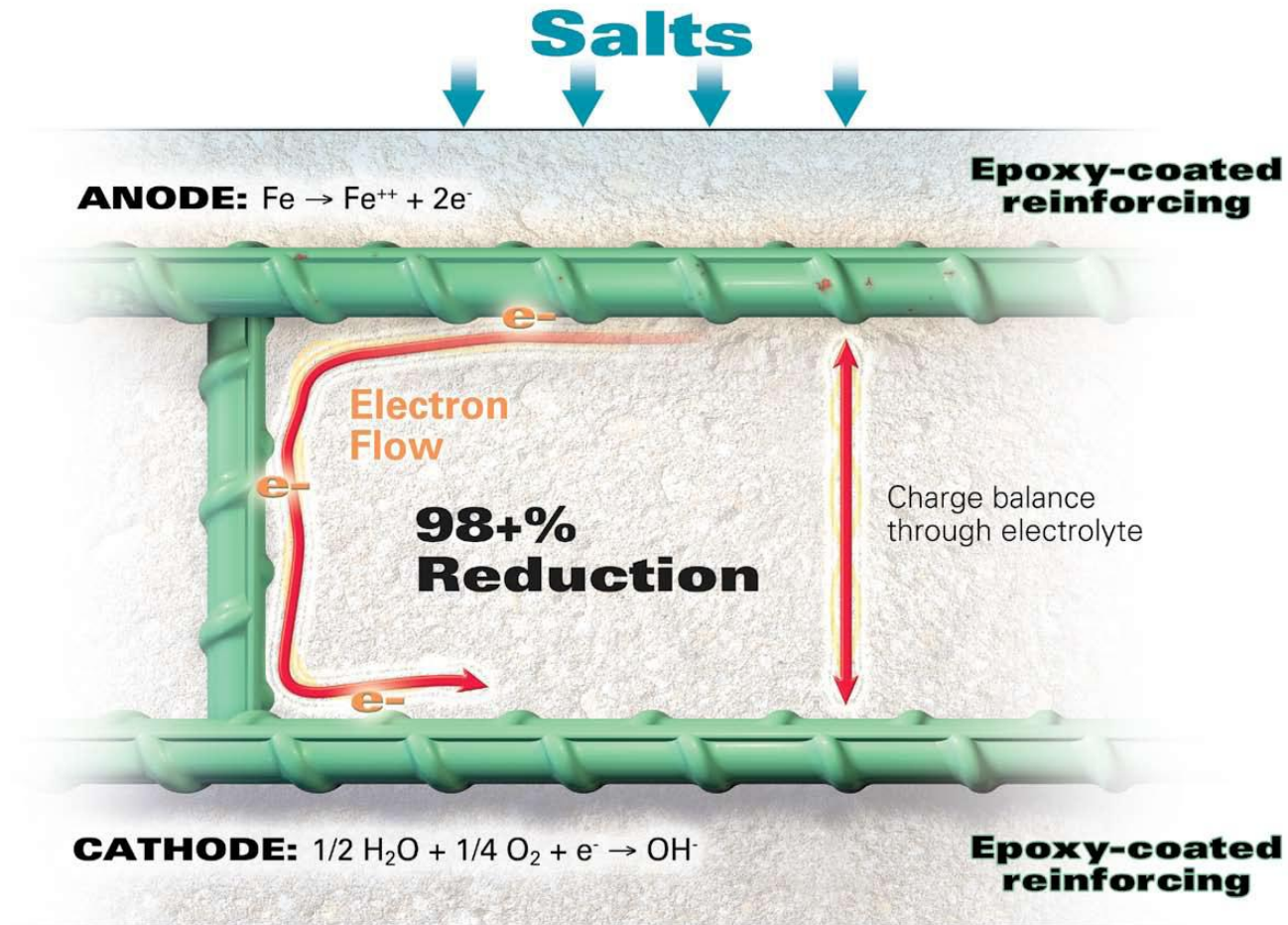
Epoxy-Coated Bars

Top mat only



Epoxy-Coated Bars

Both mats



MANUFACTURING AND QC PROCESS

CRSI Program: What is it?

- Ensures that applicator plants are capable of producing epoxy-coated steel reinforcing bars in accordance with industry standards and recommendations.

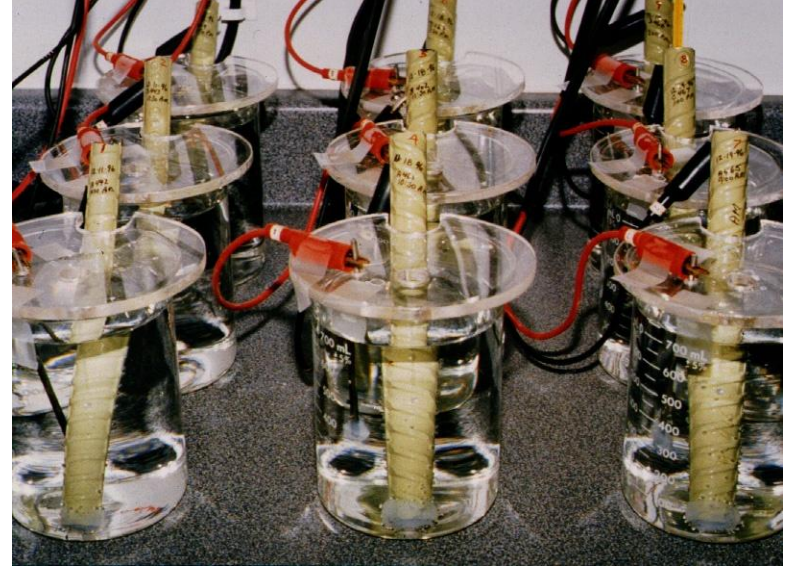
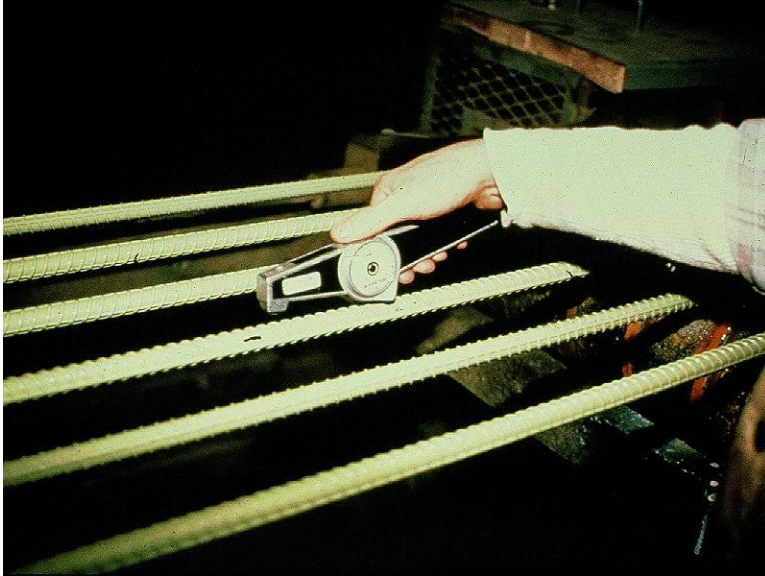


Program activities

- Records
- QC inspector
- QC equipment
- Production equipment
- Bar cleaning and coating
- Handling



Thickness, Cathodic disbondment, flexibility, storage



FIELD HANDLING

Understand the material

- Improper handling may reduce performance



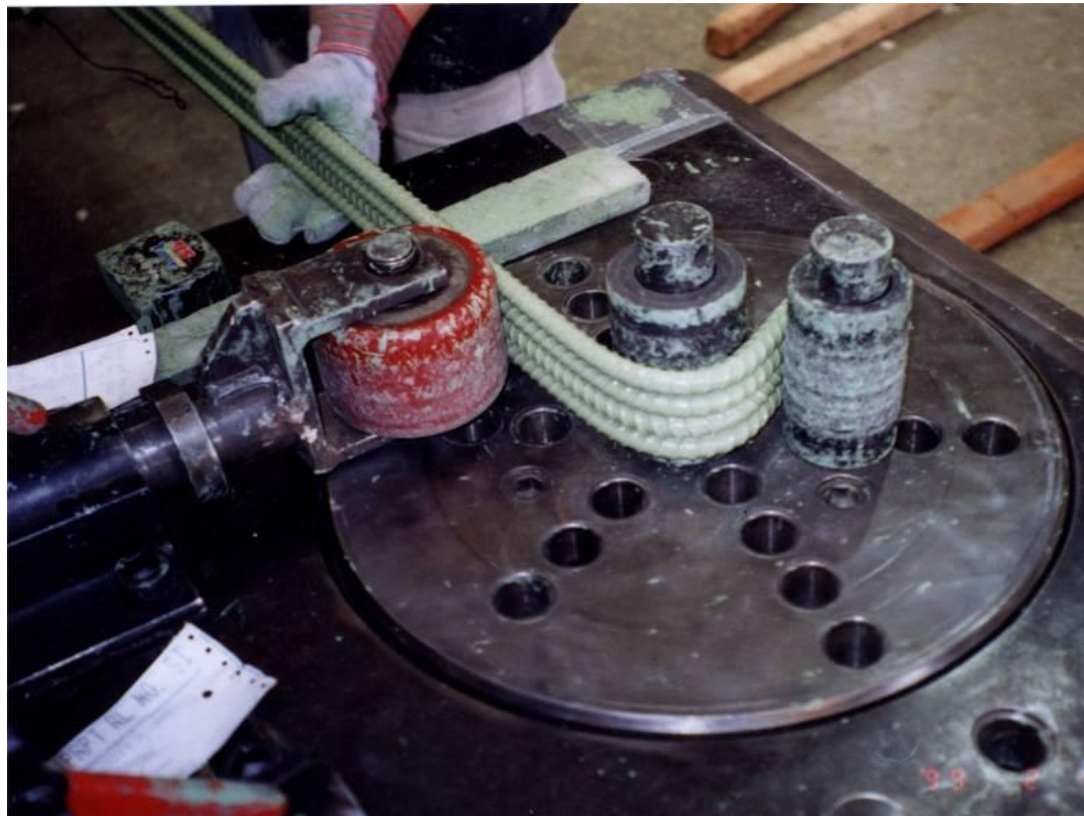
Storage

- Timber cribbing
- Opaque covering
- Store coated and uncoated bars separately



Shearing and Bending

- Minimize damage to the coating



Loading, Securing and Lifting

- Protect against damage
 - Padded material
 - Nylon strapping
 - Spreader bar
 - Multiple pick-up points
 - Unload as close as possible to the point of concrete placement
 - No bare chains or cables



Setting, Bar Supports & Tie Wire

- Lift and set bars into place
- Use non-conductive material or plastic bar supports
- Coated tie wire
- Do not drag



Patching

- Inspect bars
- Patch all damage
- Two-part epoxy repair material
- Follow manufacturer's directions



FIELD PERFORMANCE

Research and Performance

- Over 200 research papers
- Widespread use continues

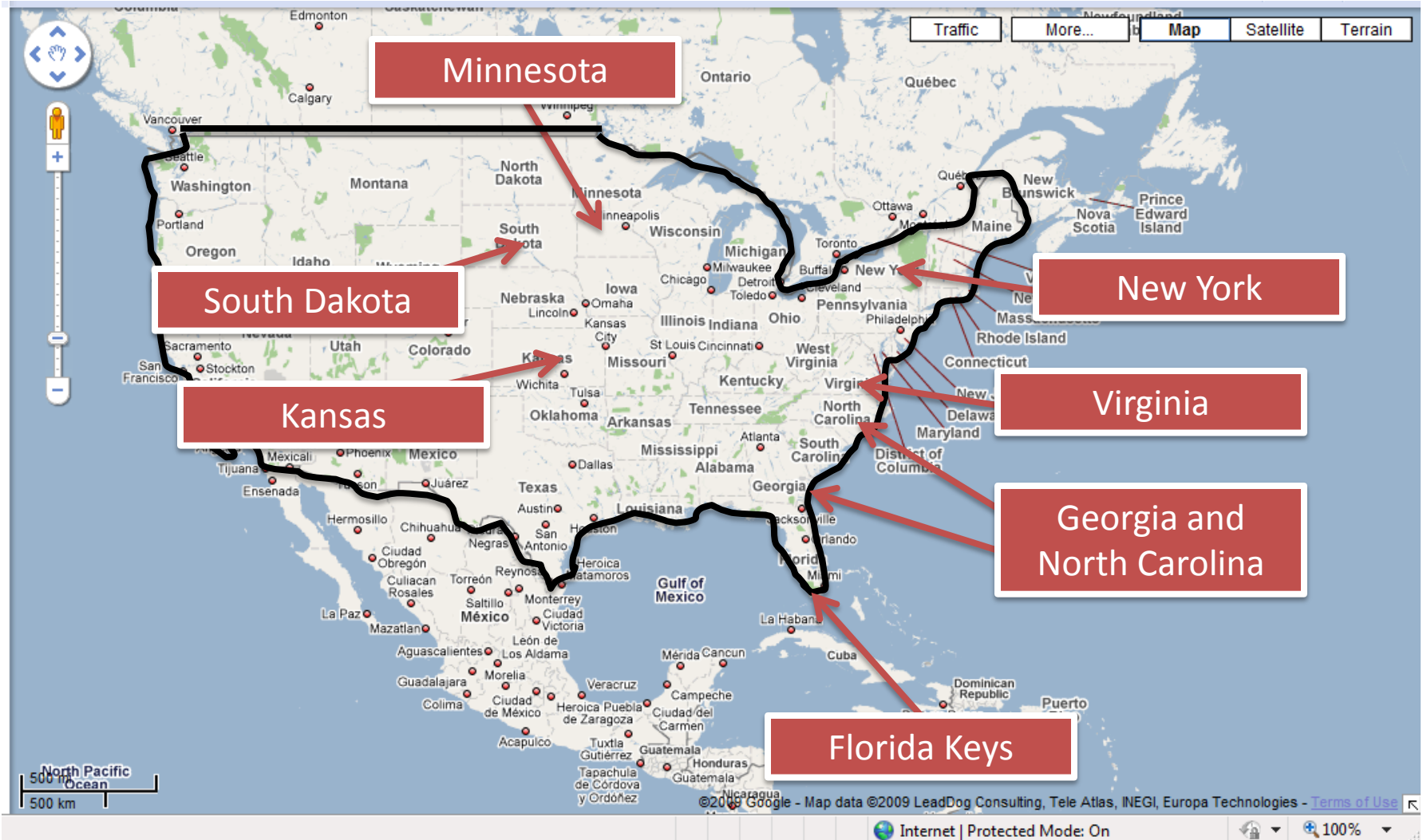


Norway

- 50% of all the larger concrete bridges had steel corrosion or had been repaired due to steel corrosion
- **Most were built during the last 25 years**
- One had to be demolished already after a service period of only 25 years

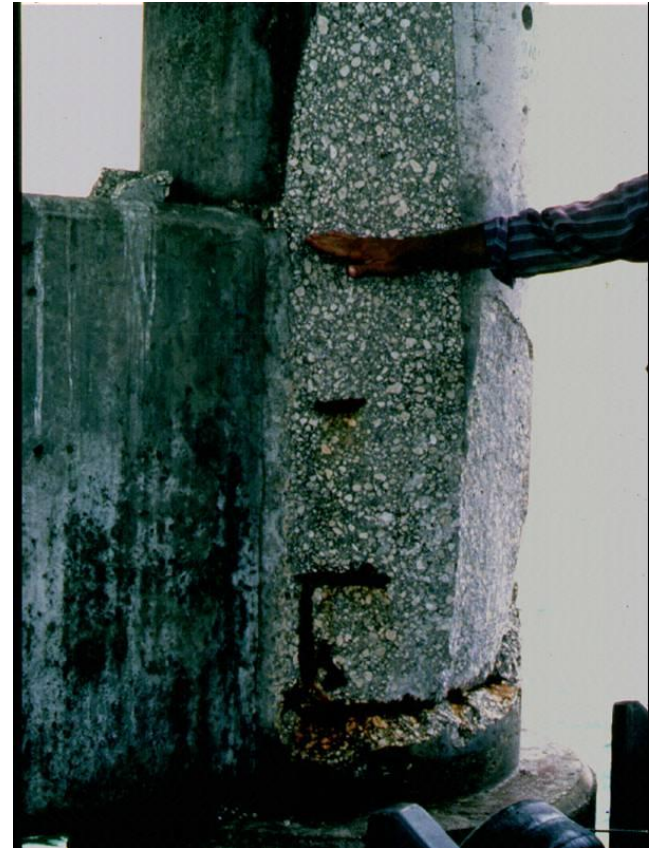


Example locations



Florida Keys

- 1986, spalls observed
- 23 years later, still only five of the 300 structures using ECR exhibit corrosion
- Extremely poor bar manufacturing
 - Bars left beside the ocean for up to a year
 - Embedded in highly salt contaminated concrete
 - Only 25 mm (1 in.) of cover.



Minnesota Department of Transportation 2008



- Four bridges built between 1973 and 1978
- Overall condition
 - good to very good, with no or modest levels of corrosion activity.
 - One bridge (bridge 19015), corrosion activity appears to be moderate to severe.
 - Corrosion constrained to the area around the joints over the bridge piers
- Amount of delamination in all decks is very low

New York State Department of Transportation 2009

- Pool of 17,000 structures
 - **“structural decks with epoxy-coated rebars perform significantly better than those with uncoated rebars, especially in the later years.”**



South Dakota Department of Transportation 2009

- Celebrated a 33-year career of Mr. Wilson from their Bridge Office.
- During this time 1,300 bridges were built.
- Implemented the use of epoxy coated reinforcing steel in bridge decks
- To date, not one of those bridge decks has needed repairs or overlay due to rebar corrosion.





West Virginia Bridge 2930

- Constructed in 1974
- Black bar - significant delamination in 1993
- Epoxy-coated bar – no delaminations or repair in 2009



Bridge 2930 Clarksburg WV

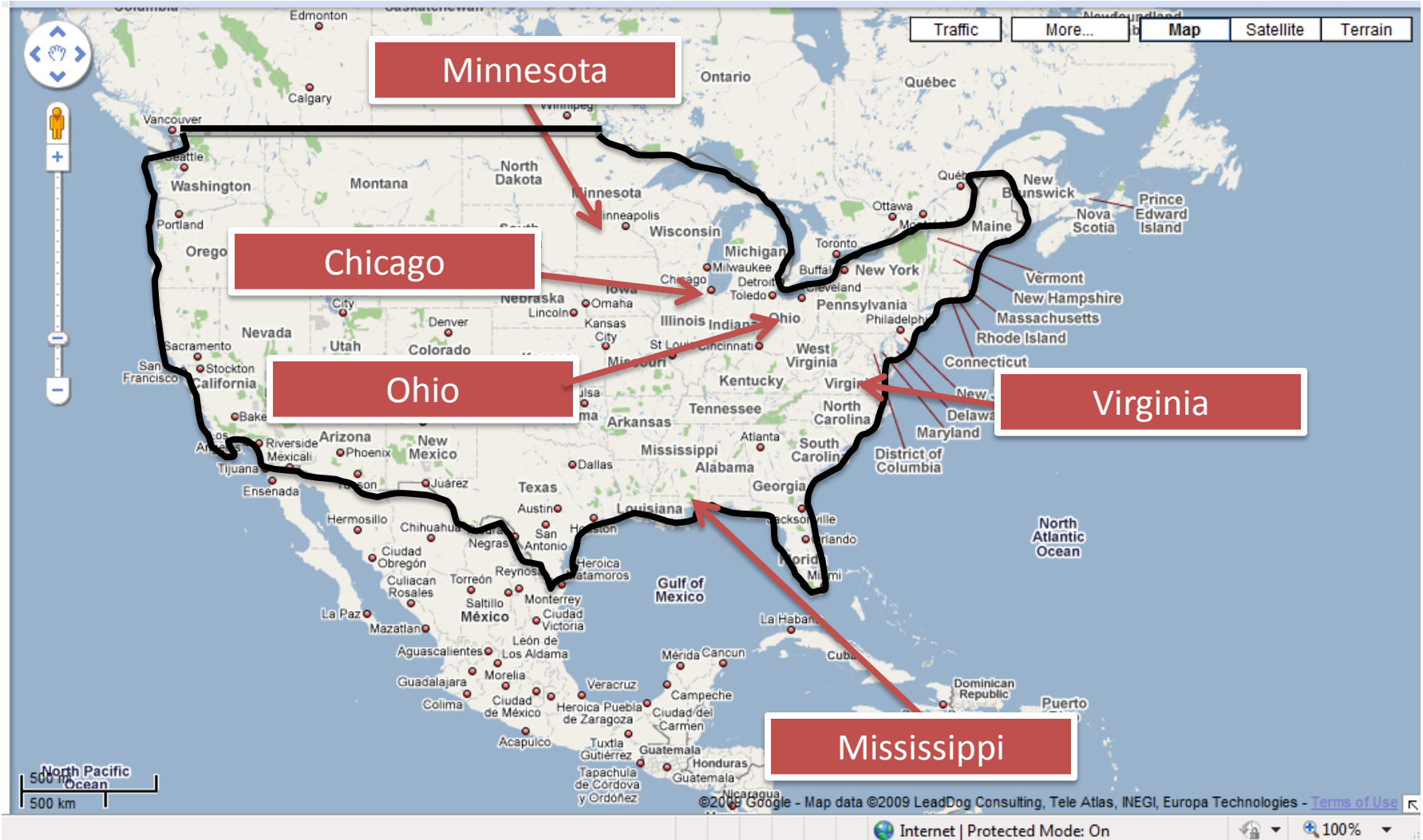


Other reports

- A researcher has postulated that any adhesion reduction will lead to catastrophic corrosion failure
 - Adhesion reduction, corrosion and concrete distress are NOT directly related
 - Widespread corrosion failure has not been observed, despite bars being in concrete with relatively chloride levels.
- Other conclusions about poor coating cure could not be substantiated

USE

Example locations





Woodrow Wilson Bridge



I-35 Minneapolis



Bridge of Honor, Ohio



Biloxi Bay Bridge

2006/2008: Woodrow Wilson, Virginia/DC

- 6075 ft (1850 m)
- 4200 tons
- 200,000 VPD
- \$680 million
 - 32,500 million INR

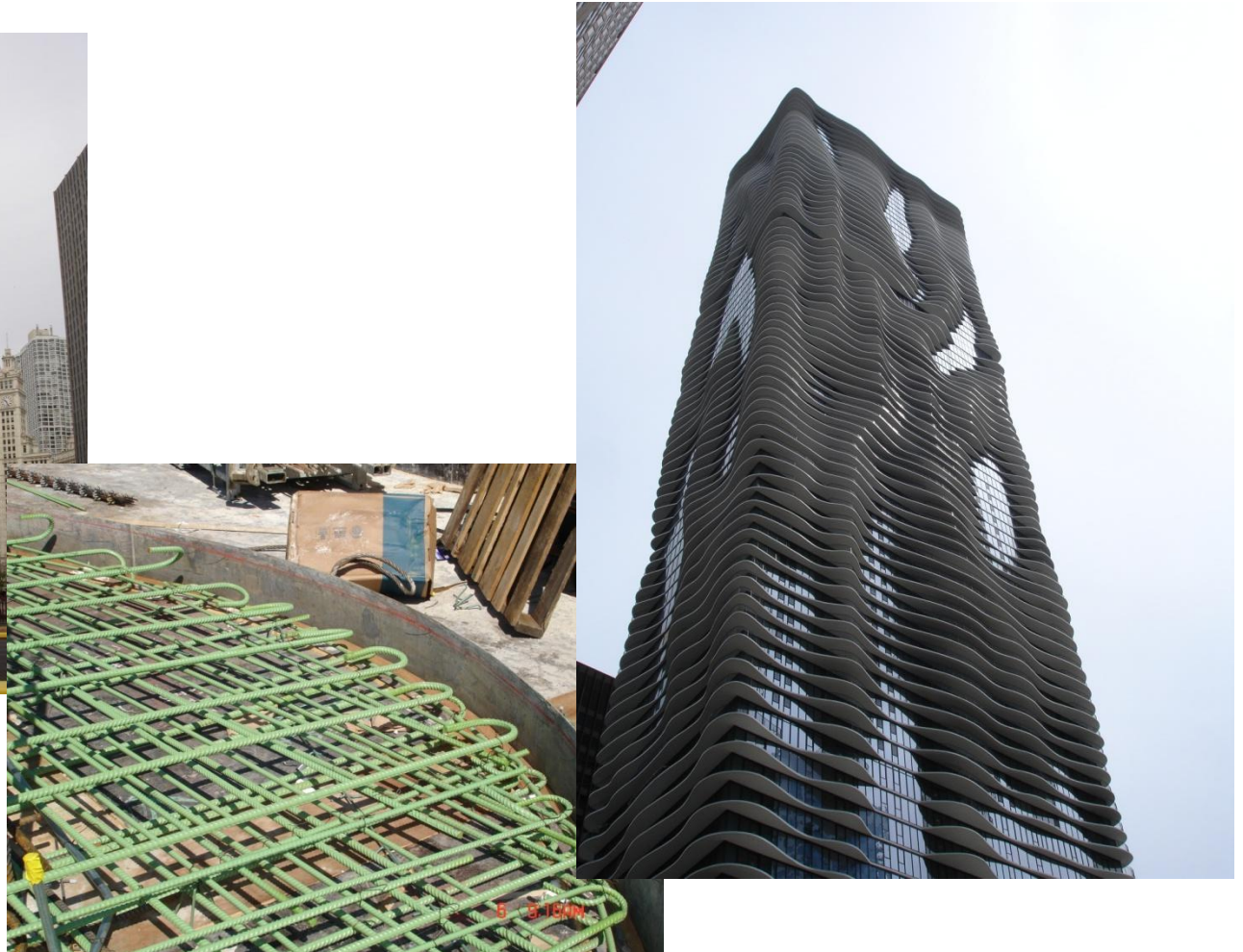


Parking Garage and Buildings

Trump International Hotel and Tower



Aqua, Chicago



Pavements



Water Treatment



CONCLUSIONS

Conclusions

- Epoxy-coated steel reinforcing bars have been used in over 65,000 bridge structures and numerous other structures
- 2nd most common strategy to prevent reinforcement corrosion
- Cost/performance better than other materials
- Manufacturing and handling must be done well to optimize performance
- Many favorable field studies

ACKNOWLEDGMENTS

