Changes that Improve Performance of Epoxy-Coated Reinforcing Steel

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Epoxy Bar Use

- 700,000,000 ft^2 of decks
- 65,000 bridges
- North America
  - ~600,000 ton/yr or 10 - 15% of all rebar
- Middle East
  - ~150,000 ton/yr
- Japan, Korea, China and India

How do you do to ensure your paint is durable?

- Preparation
- Material
- Application

1974 National Bureau of Standards

- Proper substrate preparation
- Correct powder application
  - Well-cured
  - Essentially free from holidays
  - Flexible films
- Repairs using liquid epoxy just prior to casting

How can I make coated reinforcement perform poorly?

- Poor steel selection
- Chloride contamination
- Poor surface profile
- Surface contamination
- Low coating thickness
- Over-heating or under-curing
- Poor handling of reinforcement after coating

Manufacturing specifications

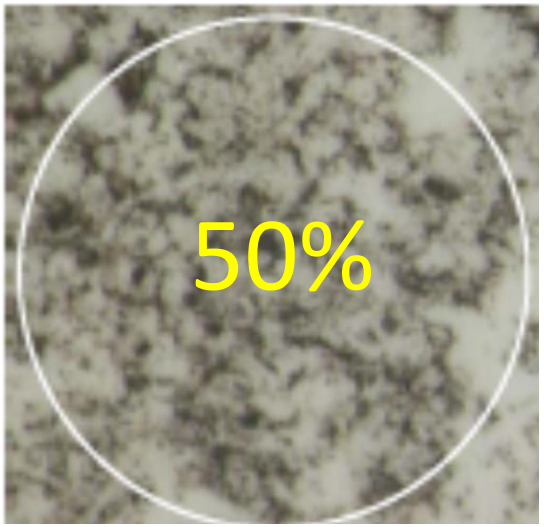
Criteria	1980's	2007
Bar anchor profile	-	1.5-4 mil
Coating delay after blasting	< 8 hours	< 3 hours *Mostly within minutes*
Coating thickness	90 percent within 5-9 mil	7-12 mil (Nos. 3-5) 7-16 mil (Nos. 6-18)
Coating continuity	< 2 holidays per foot	< 1 holiday per foot
Coating flexibility	120 degree bend	180 degree bend
Cathodic disbondment test	-	Yes

CRSI Plant Certification Program

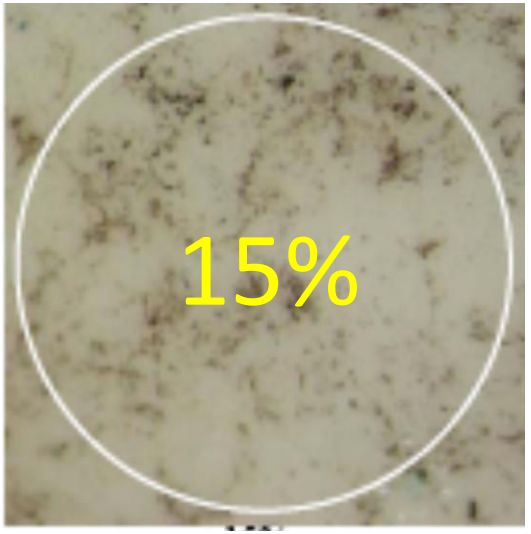
- Introduced in 1991 to improve bar quality
- Almost all plants in North America
- Referenced by 23 transportation agencies

Backside contamination

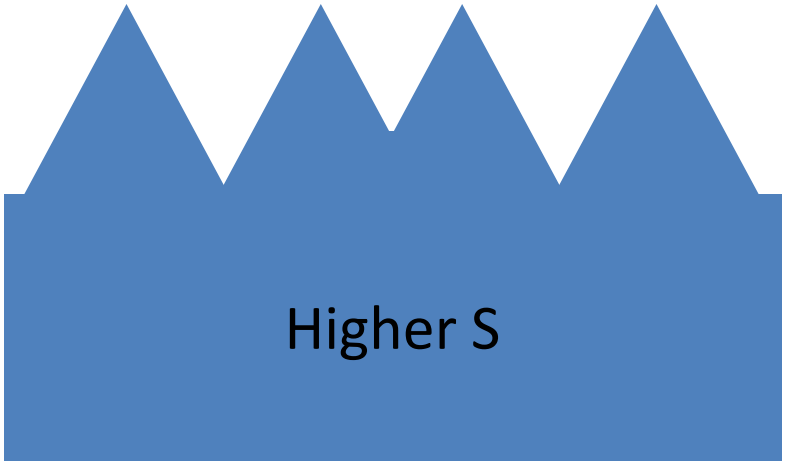
- 1992: Median contamination was 25%...from 10 to 70%



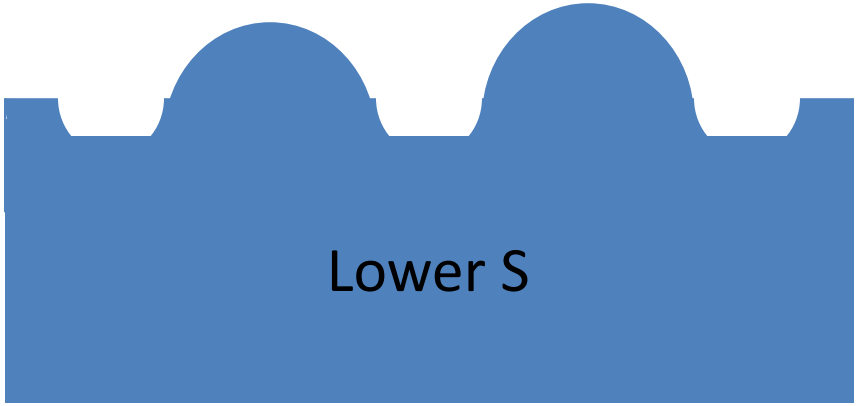
- 2011: Average contamination less than 15%



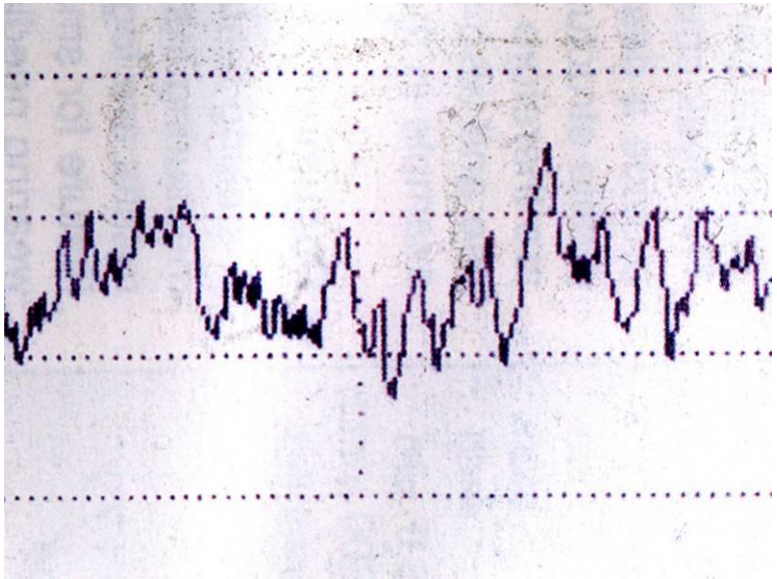
Anchor Profile



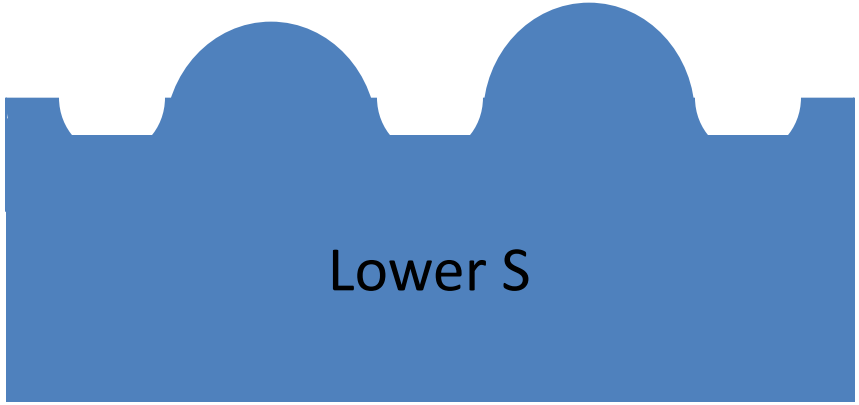
Preferred Profile



Profile not measured in 1980s



Anchor Profile



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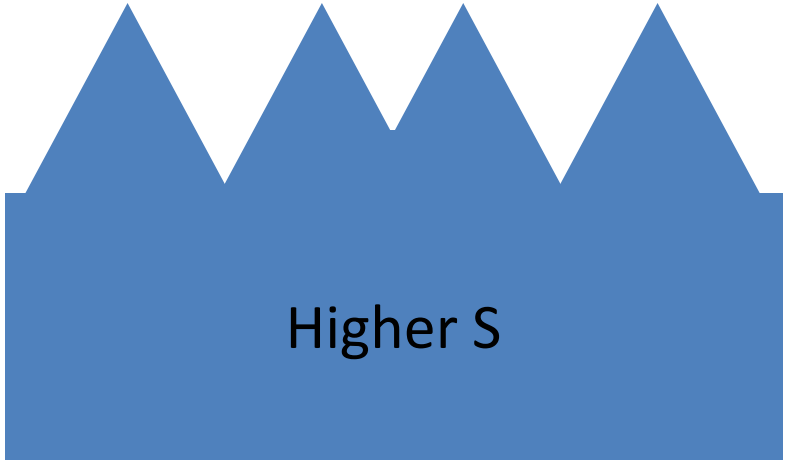

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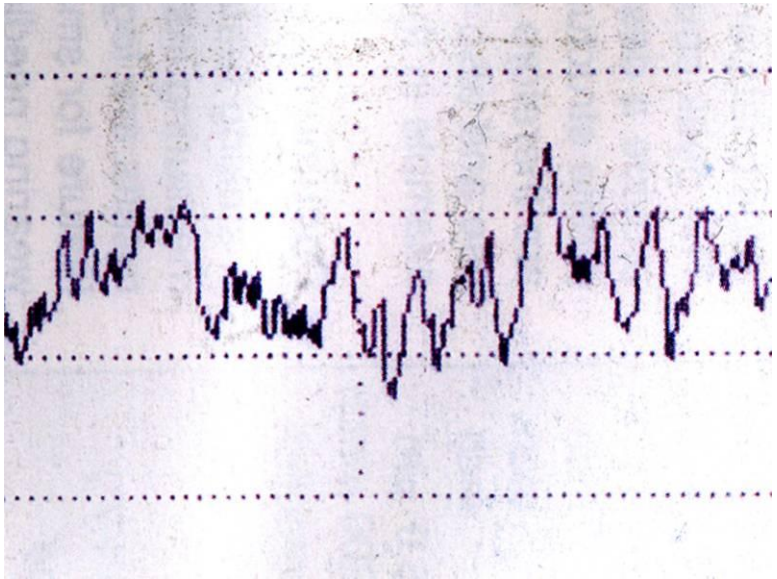
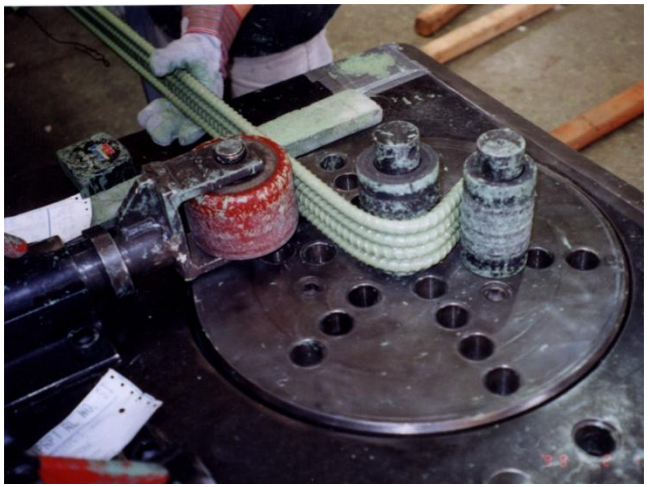


Bending

- 1992: Cracks at bends varied…zero to 32 cracks at the bends
  - Bending to 120°



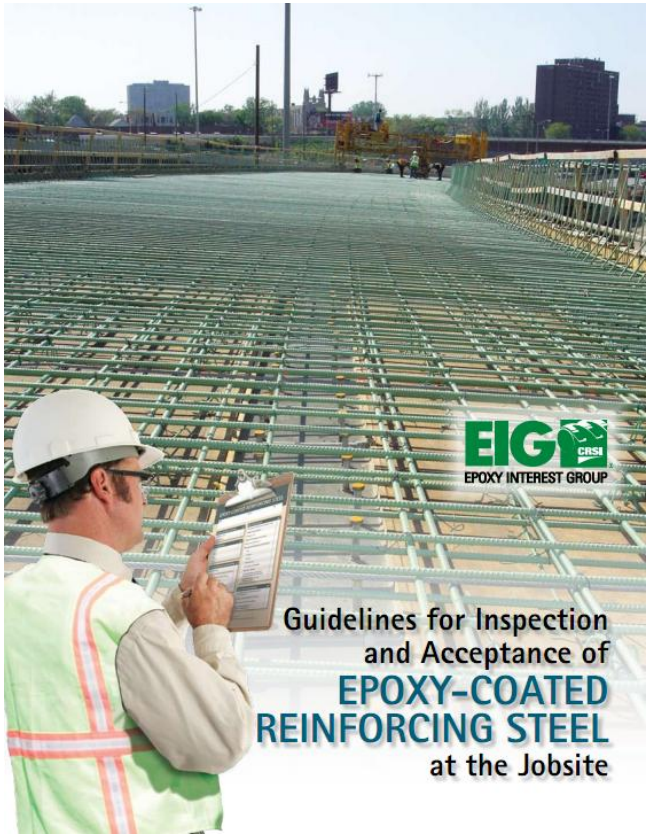
- 2011: Cracks in coating not allowed
  - Bending to 180°

D3963 Field Handling

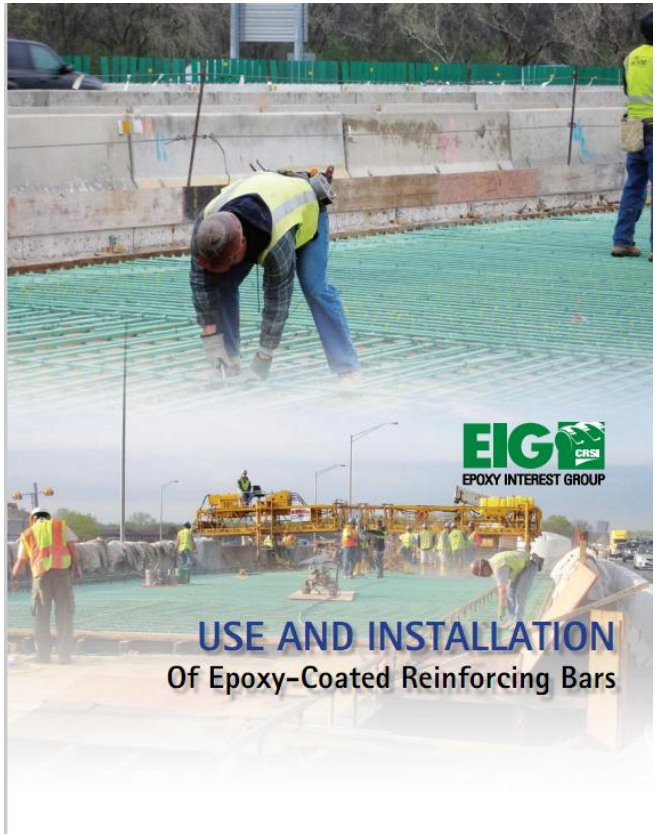
Criteria	1980's	2007
Patching	None if < 0.1 in^2	All damage must be patched
Maximum damage	Maximum damage level 2 percent	Maximum damage level 1 percent
Storage protection	-	Yes, if > 2 months

Additional Information

Inspectors



Field Crews



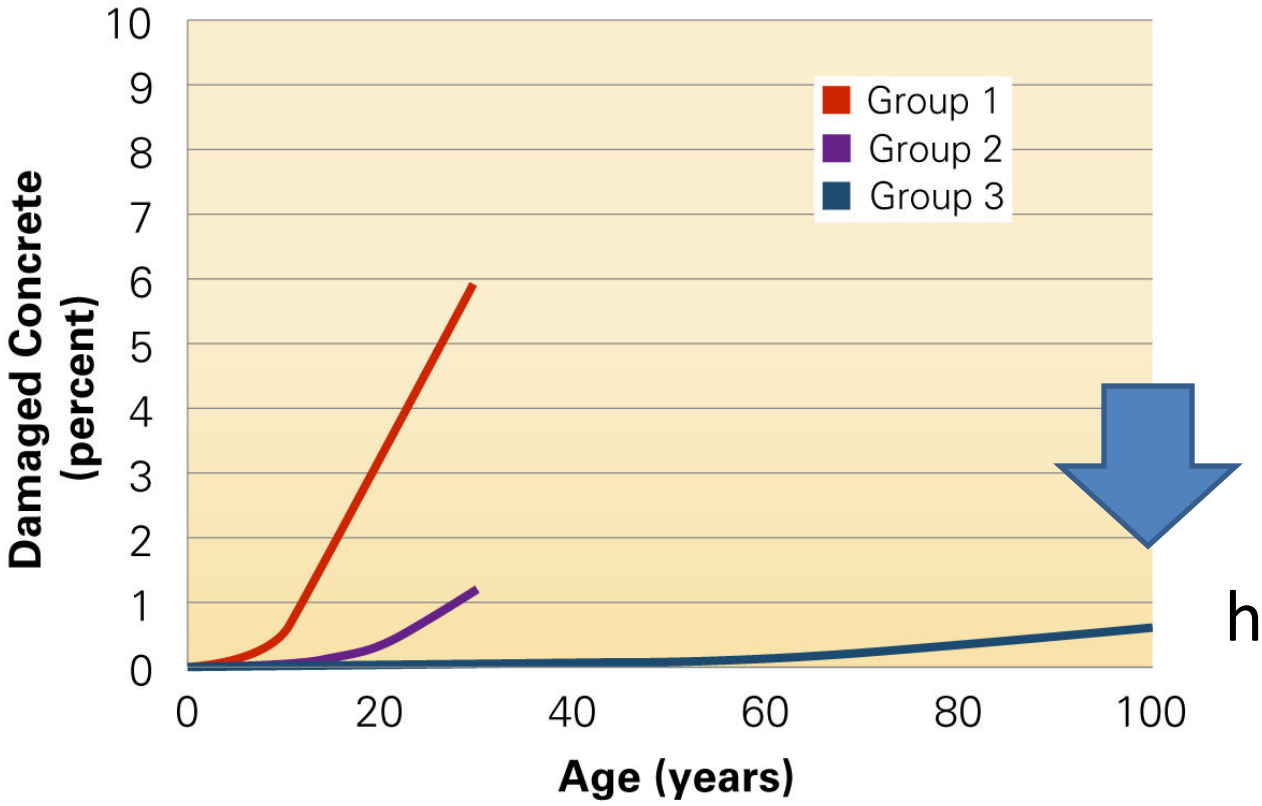
FIELD PERFORMANCE

Florida Bridges

- Poor Concrete
- Poor Cover
- Chloride contamination
- Aggressive environment
- Poorly manufactured and stored reinforcement

Poor quality concrete and coatings leading to poor life

Florida Predictions



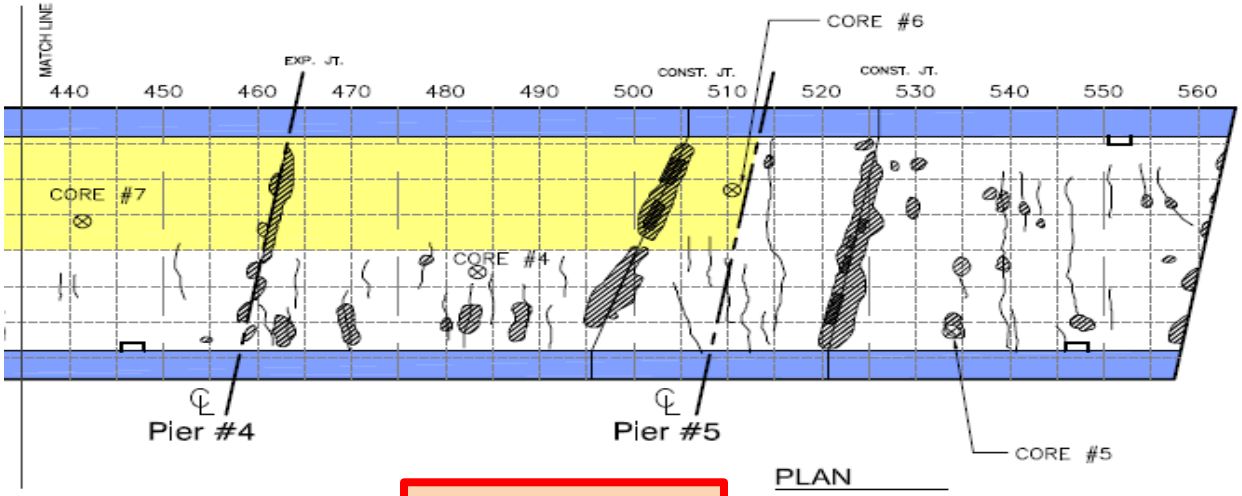
Most structures containing epoxy reinforcement in Florida concrete are predicted to have a 100 year life

After Sagues et al.

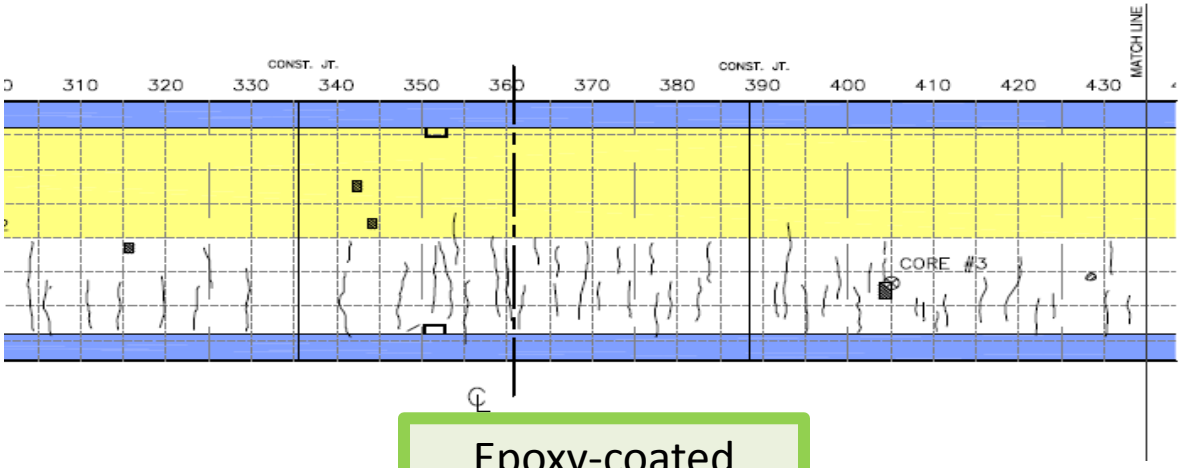
New York State Department of Transportation 2009

- Statistical analysis of 17,000 structures
- Structural decks with epoxy-coated reinforcement perform significantly better than those with uncoated reinforcement, especially in the later years.

West Virginia 2009



Black reinforcement



Epoxy-coated reinforcement

Conclusion

- Poorly coated reinforcement performs poorly
- Well coated reinforcement performs well
  - particularly in good quality concrete
- Certification programs have led to improved manufacturing practices
- ASTM specifications have been improved to reflect current knowledge
- Epoxy-coated reinforcement use has increased worldwide