Innovative Products
Tested by FDOT

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June 17, 2013

Florida Department of Transportation

SCOBS, AASHTO Technical Committee
T-9 Bridge Preservation
Florida has been looking for rebar products that will not corrode even if the concrete is cracked, poorly consolidated, and/or with zero concrete cover.
Florida DOT Policy

• A rebar having a higher chloride threshold is not enough for Florida.
• Some of the cost of the product has to be recovered by use of less cover, total cementitious, or both.
• We will still use slag and/or fly ash regardless of rebar used
**SERVICE LIFE CONCEPT**

- **DAMAGE**
- **CRITICAL**
- **TIME**
- **INITIATION**
- **PROPAGATION**

- $C_{th} = 1.2$ Lbs/Yd$^3$
- First Crack

- 10 Years
Stainless Steels
Notes:
- All bars as received.
- Indicates not all samples in the set have shown signs of corrosion.
- 1/3, 1 indicates # of active specimens, 3 indicates total # of.

3-BAR TOMBSTONE PERFORMANCE

High Permeability Concrete (STD3)

Control - Straight Bar
- BENT
- Elevated Bar

Moderate Permeability Concrete (STD2)

Control - Straight Bar
Macrocell Slab Specimens Performance
Effects of Environment, Concrete, & Preparation
on Time to Corrosion

Notes:
- All bars wire brushed
- Indicates not all samples in the set have shown signs of corrosion
- 1/3, 1 indicates # of active specimens, 3 indicates total # of specimens

Very High Permeability (STD1)

Control-Outdoor
Control- Controlled Exposure
77°F, 50% RH
Anode as Received,
Moderate Permeability (STD2), Outdoor Exposure
Macrocell Slab Specimens Performance
Effects of Cracked Concrete on Time to Corrosion

Notes:
- All bars wire brushed
- ↑ Indicates not all samples in the set have shown signs of corrosion
- 1/3, 1 indicates # of active specimens, 3 indicates total # of specimens
- All specimens cast using very high permeability concrete (STD1) &

- Control
- Black Carbon Cathode
- Bent Anode
- Bent Anode, Black Carbon

Average Days to Initiation

(corrosion on cathode bar)
Field Specimens
Z-Bar: Dual Zinc/Epoxy Coating
Corrosion Inhibitors

- Expensive Products
- A lot of Lab data confirming benefit
- Hard to predict performance in actual concrete
- Diffusion issues of inhibitors themselves
Laboratory 3-Bar Tombstone Columns

Time to Corrosion Initiation (-280mV vs. SCE)
Oldest Test Tanks at FDOT

Tide Changes Every 6 Hours

14.0 cm (5.5”)  
3.81 cm (1.5”)

Overflow

3.5% NaCl

Fiberglass Tank
Project Specimen Exposure Times

- CTRL-2-STD: 3/3
- CTRL-1-STD: 3/3
- Corrosion Inhibitor 2: 3/3
- Inorganic Polymer Coatings: 12/12
- Calcium Nitrite: 3/3
- 8% SFFA repl: 3/3
- Epoxy coated rebar: 4/6
- Penetrant sealers: 6/6
- Corrosion Inhibitor 3: 3/3
- Fly Ash: 8/9
- Super Fine Fly Ash: 0/9
- Galvanized rebar*: 3/3
- Silica Fume: 0/21

* Concrete cracked prematurely, most likely due to zinc oxide formation
Coatings for Steel Bridges

- Polymer coatings do not last long enough
- Polymer Coatings were not designed for long service lives due to UV
- Recoating is very expensive
Zinc Vapor “Galvanizing”

**This is for steel bridges and not for rebar yet as it has not been studied in concrete.**

**ASTM A 1059:**锌合金热扩散涂层（TDC）在钢螺栓、螺母和其他产品

**Sherardizing:** 一种热扩散过程，产生一种牺牲性的锌/铁合金层，提供均匀的抗腐蚀保护。
Phosphate Bonded Coatings

- Ceramic Material not susceptible to UV
- Reacts with steel to form bond (chemical covalent bond)
- Inert alloy between metal and ceramic
- Used in Reactive and hazardous waste industry
FDOT Rebar Moving Forward

• Mill scale has to be properly removed using both blasting and pickling.
• FDOT will use: 304, 316, 2205, or better. Any SS with a good amount of Mo.
• Rebar that shows promise pending further Research: 2304, Z-Bar, 2101, Basalt, GFRP,
• Rebar that FDOT has determined not to be good for use: MMFX, EnduraMet 32, 3Cr12, ECR, galvanized, inhibitors
FDOT Steel Coatings Moving Forward

• Vapor Zinc Galvanizing (VZG) looks very promising based on salt spray tests. Field test under way.

• Phosphate bonded Coatings look like they should work. A lot of work ahead still to confirm.
Questions?