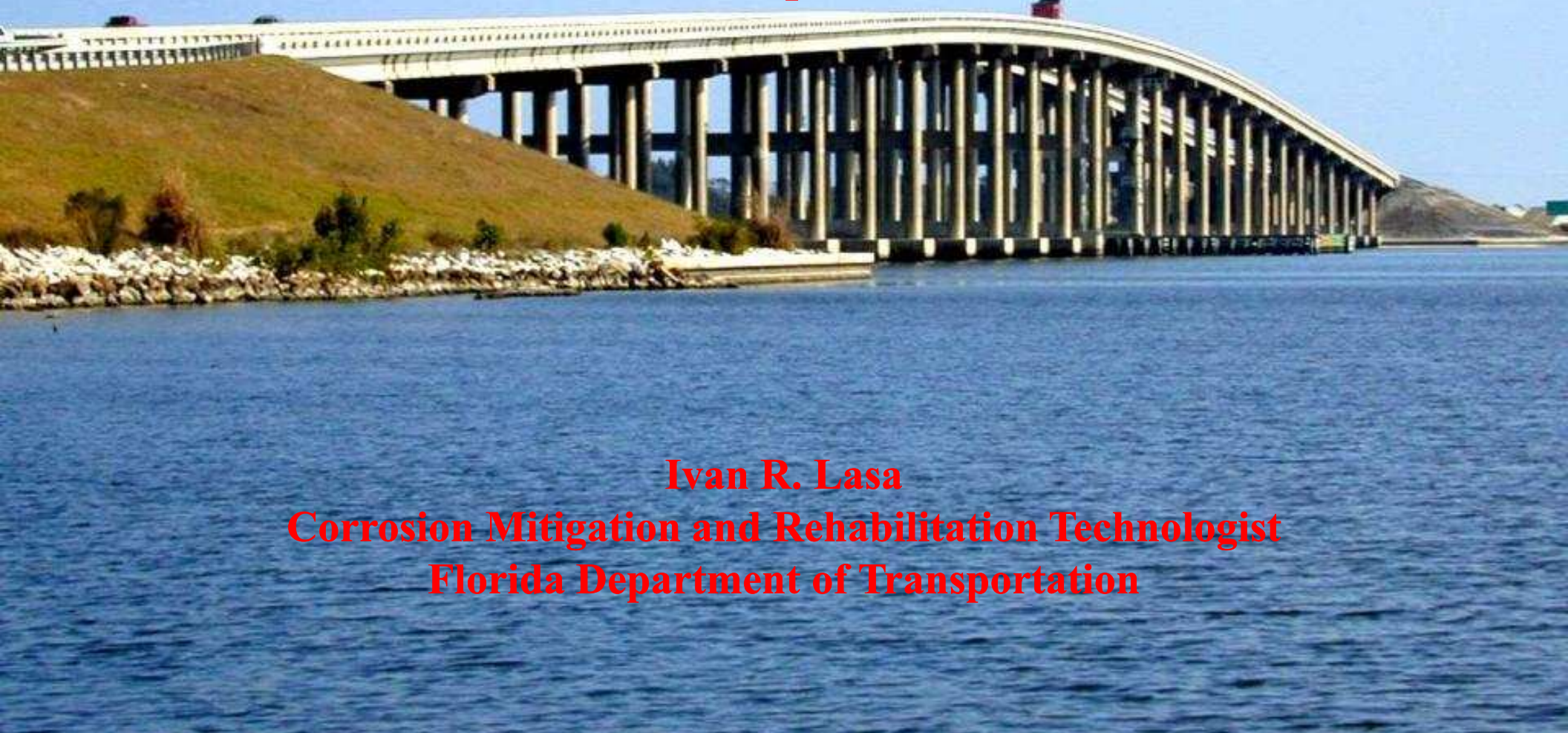


CATHODIC PROTECTION PRACTICES IN FLORIDA

**Southeast Bridge Preservation Partnership Annual Meeting
Orlando, FL - April 27 – 29, 2010**



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Corrosion Mitigation and Rehabilitation Technologist
Florida Department of Transportation**

- OVER 8,000 MILES OF TIDAL COAST LINE *

- ENTIRE COASTAL AREA IS CONSIDERED EXTREMELY CORROSIVE.

- THE MOST COMMON TYPE OF DETERIORATION ON FLORIDA MARINE BRIDGES IS CORROSION INDUCED DAMAGE TO SUBSTRUCTURE COMPONENTS.



* Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. <http://www.infoplease.com/ipa/A0001801.html>

TYPICAL DETERIORATION

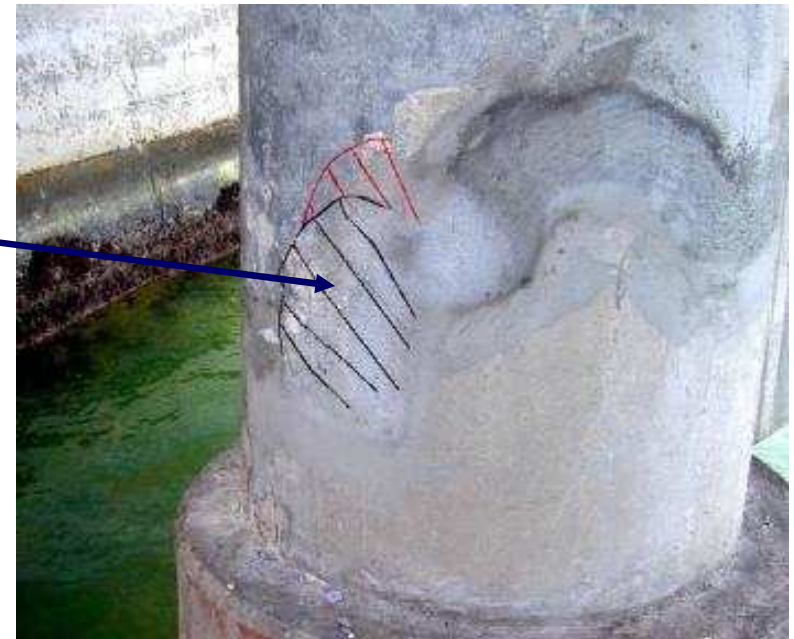


CONVENTIONAL REPAIRS ON CHLORIDE CONTAMINATED CONCRETE



**- EVEN WHEN A GOOD
ENCAPSULATION IS
ACHIEVED, NEW CORROSION
CELLS ARE DEVELOPED AND
CORROSION CONTINUES**

**- CORROSION DEVELOPS AROUND
THE REPAIR DUE TO THE
CHARACTERISTICS CHANGE OF
THE REPAIRED REBAR. ***



* NCHRP D10-37C

CONVENTIONAL REPAIRS FAILURES



- REMOVAL OF STANDARD JACKETS SHOWED THAT CONVENTIONAL ENCAPSULATIONS ALLOW CONTINUED CORROSION.

- GOOD PATCHES PROMOTE ACCELERATED CORROSION IN THE CONCRETE SURROUNDING THE PATCH AND NEW SPALLS DEVELOP IN A FEW YEARS.



CATHODIC PROTECTION PRACTICES

- **IN EARLY 1980'S FDOT DETERMINES THAT CONVENTIONAL REPAIRS ARE NOT ADEQUATE FOR THE REHABILITATION OF CHLORIDE CONTAMINATED STRUCTURES.**
- **FDOT APPROACH TO PRESERVE THESE CORROSION AFFECTED BRIDGES IS BASED ON THE CONCEPTS OF CORROSION CONTROL USING CATHODIC PROTECTION AND CONCRETE REHABILITATION.**
- **GOAL: TO PROVIDE AN EXTENSION OF THE SERVICE LIFE AS NEEDED.**

CATHODIC PROTECTION PRACTICES

- IMPLEMENTED IN A CASE BY CASE BASIS.

- a. No standard specifications have been developed.**
- b. Cause and magnitude of corrosion activity determined prior to design of rehabilitation.**
- c. Type of cathodic protection determined based on needs.**

- FDOT HAS A WORKGROUP SOLELY DEDICATED TO CORROSION ISSUES TO ASSIST THE DISTRICTS.

- a. Provides corrosion condition assessment & recommendations.**
- b. Provides technical support for design and construction.**
- c. Monitor and maintains the cathodic protection systems.**
- d. Districts have final decision on approach to take.**

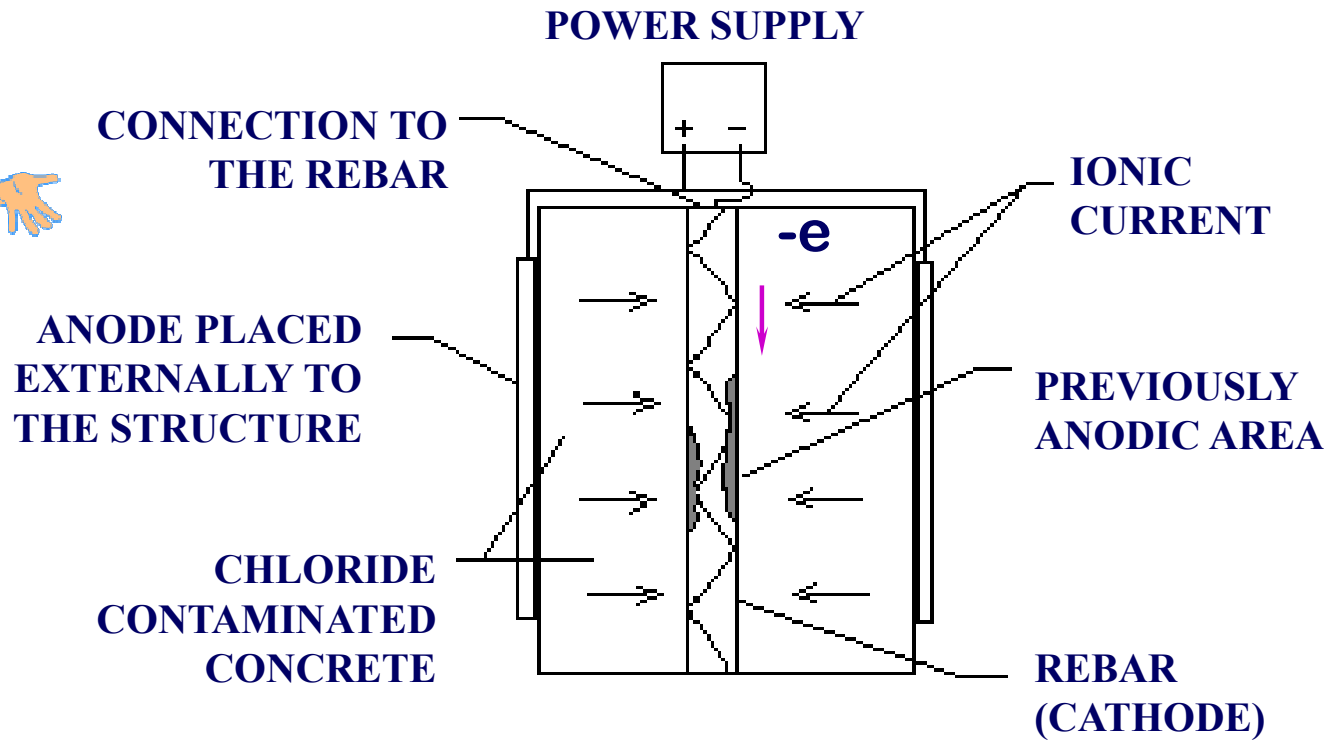
CATHODIC PROTECTION PRACTICES

Highlights of Implementation:

- A) Structural Analysis and Evaluation of Deterioration.**
- B) Rehabilitation of Concrete and Reinforcement
Provided as Needed.**
- C) Implementation of Corrosion Control Measures:
 - 1. Impressed Current Cathodic Protection.**
 - 2. Sacrificial (galvanic) Cathodic Protection.****
- D) Routine Inspection of Structure, and Monitoring
the Performance of Cathodic Protection.**

IMPRESSED CURRENT CATHODIC PROTECTION

Cathodic Protection?



- A CATHODIC PROTECTION CIRCUIT CONTAINS THE SAME FOUR BASIC COMPONENTS OF A TYPICAL CORROSION CELL.
- TRANSFER OF ELECTRONS FROM THE ANODE TO THE CATHODE IS ALSO SIMILAR TO A CORROSION CELL.

Cathodic Protection Systems Used by FDOT

- 1- Ti Mesh Anode Encapsulated in Shotcrete/Mortar**
- 2- Ti Mesh Anode Encapsulated in Structural Reinforced Concrete**
- 3- Ti Mesh Anode in Conventional Pile Jackets**
- 4- Thermal-Sprayed Zinc Anode in Sacrificial Mode**
- 5- Zinc Mesh Anode in Conventional Pile Jackets**
- 6- Submerged Bulk Anode Systems (Zn or Al)**

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

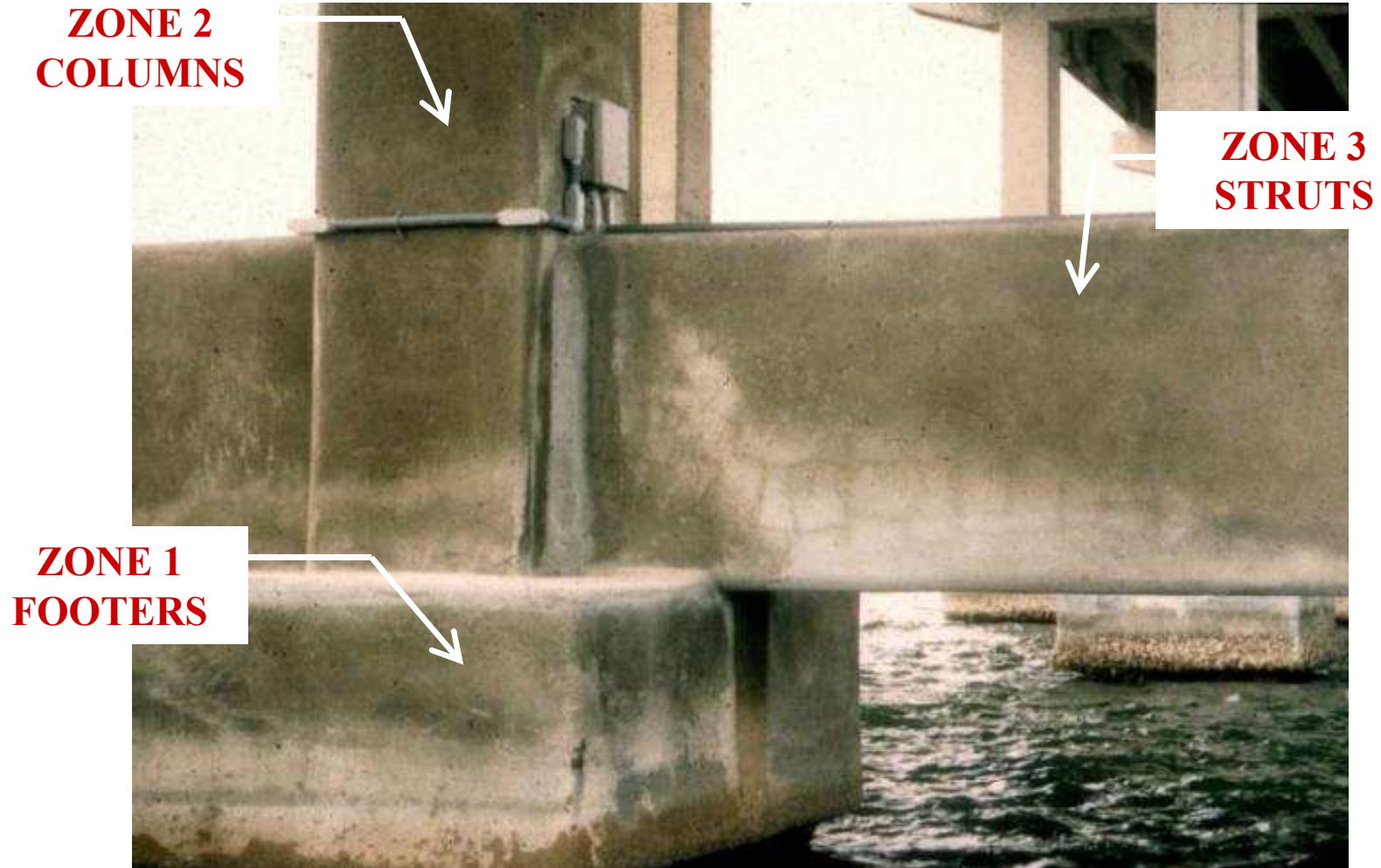
TITANIUM ANODE MESH



- **TYPICALLY ATTACHED TO THE CONCRETE SURFACE AND THEN ENCAPSULATED IN CEMENTITIOUS MATERIALS.**
- **EASILY CONFORMS TO THE STRUCTURE GEOMETRY.**
- **MOST USED IMPRESSED CURRENT ANODE FOR CONCRETE.**

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH



- ENCAPSULATION WITH MACHINE APPLIED MORTAR (SHOTCRETE).

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH



- ENCAPSULATION IN STRUCTURAL CONCRETE**
- INCLUDES PLACEMENT OF ADDITIONAL REINFORCEMENT**
- C.P. PROVIDED FOR NEW AND EXISTING REINFORCEMENT**

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH



- WIRES ARE ROUTED TO THE RECTIFIER IN CONDUIT.

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH

ENCAPSULATION OF Ti ANODE WITHIN A STANDARD PILE JACKET.

A FIBERGLASS FORM IS PLACED AROUND THE PILE LEAVING AN ANNULAR SPACE BETWEEN PILE AND FORM.

FORM IS FILLED WITH MORTAR/CONCRETE.

SEVERAL PILES ARE COMBINED INTO ONE C.P. CIRCUIT.



IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH



- THE TITANIUM MESH ANODE IS PRE-INSTALLED INSIDE THE STAY-IN-PLACE FIBERGLASS FORM FOR A CIRCULAR COLUMN**

SACRIFICIAL CATHODIC PROTECTION

ARC-SPRAYED ZINC



- **ZINC ANODE IS APPLIED OVER CONCRETE SURFACE.**
- **NEEDS A DIRECT CONNECTION TO THE REINFORCEMENT.**

- **APPLICATION SIMILAR TO SPRAY PAINTING.**
- **CAN BE USED WITHOUT CONCRETE RESTORATION BY APPLICATION DIRECTLY TO THE REINFORCEMENT TO SERVE AS CONNECTION.**



SACRIFICIAL CATHODIC PROTECTION

ARC-SPRAYED ZINC

**THERMALLY SPRAYED ZINC
ALSO USED ON STRUCTURAL
STEEL AS A PROTECTIVE
COATING WITH A PAINT
SYSTEM OVERCOAT.**



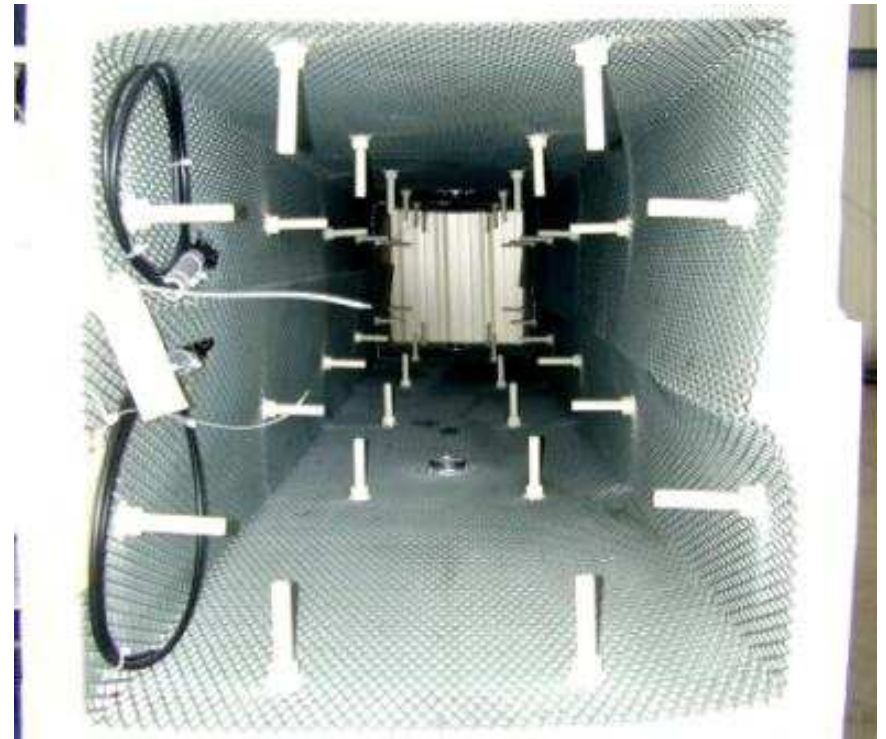
SACRIFICIAL CATHODIC PROTECTION

EXPANDED ZINC MESH ANODE JACKET



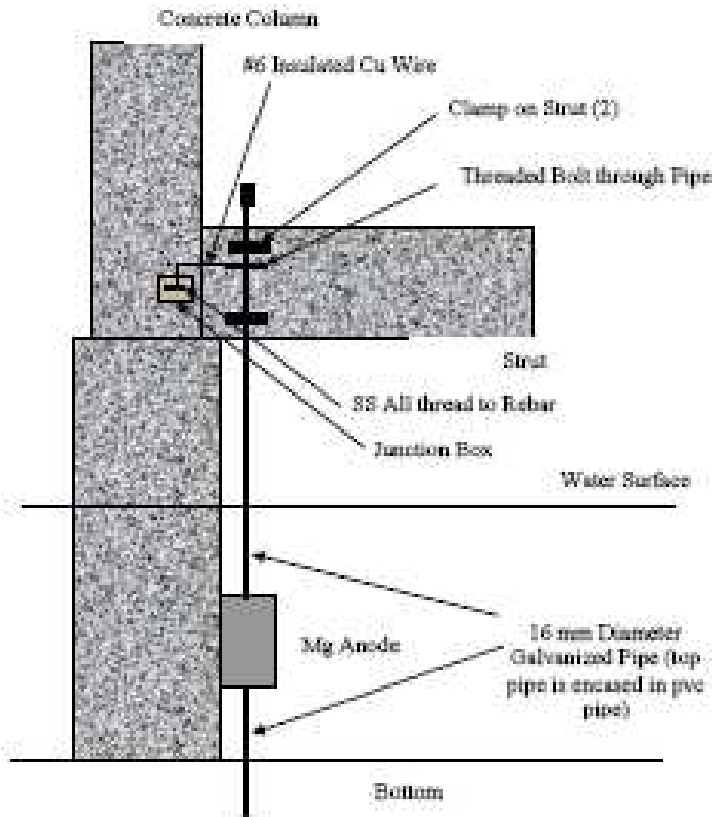
SACRIFICIAL C.P. JACKET IS PLACED AROUND THE PILE AND CONNECTED DIRECTLY TO THE REINFORCEMENT WITHOUT AN EXTERNAL POWER SUPPLY.

THE ZINC MESH ANODE IS PRE-INSTALLED INSIDE THE FORM TO PROVIDE AN ANNULAR SPACE OF 50 mm WHICH IS LATER FILLED WITH MORTAR.



SACRIFICIAL CATHODIC PROTECTION

SUBMERGED BULK ANODES



THESE ANODES ARE MOSTLY USED TO PROVIDE CATHODIC PROTECTION TO STRUCTURES WITH UNDERWATER DAMAGE. SIMILAR ARE ALSO USED TO COMPLEMENT GALVANIC PILE JACKETS.

CONCLUSIONS

- FDOT CATHODIC PROTECTION PROGRAM HAS BEEN SUCCESSFUL IN EXTENDING THE SERVICE LIFE OF BRIDGES IN MARINE ENVIRONMENTS.**
- THE CATHODIC PROTECTION PROGRAM HAS PROVEN TO BE A COST EFFECTIVE MEANS TO PRESERVE CORROSION EFFECTED STRUCTURES.**
- THE PROGRAM IS MAINTAINED BY A WORK GROUP SOLELY DEDICATED TO CORROSION AND CATHODIC PROTECTION. CONTINUITY IN MONITORING AND MAINTENANCE IS PROVIDED.**



THANKS