CATHODIC PROTECTION PRACTICES IN FLORIDA

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INTRODUCTION

IN FLORIDA

- OVER 8,000 MILES OF TIDAL COAST LINE.

- ENTIRE COASTAL AREA IS CONSIDERED EXTREMELY CORROSIVE.

- AROUND 12000 BRIDGES IN INVENTORY.

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

TYPICAL DETERIORATION

TYPICAL DETERIORATION

MOST OF THE CORROSION ON FLORIDA BRIDGES DEVELOPS ON THE BRIDGE SUBSTUCTURE

- **OLD AS WELL AS NEWER STRUCTURES MAY SUFFER FROM CORROSION.**

CONVENTIONAL REPAIRS ON CHLORIDE CONTAMINATED CONCRETE

- **FOR MANY YEARS CONVENTIONAL REPAIRS WERE THE STANDARD FOR PRESERVATION OF THE STRUCTURES, BUT WITH NEGATIVE RESULTS WHEN CHLORIDES ARE ALREADY PRESENT.**

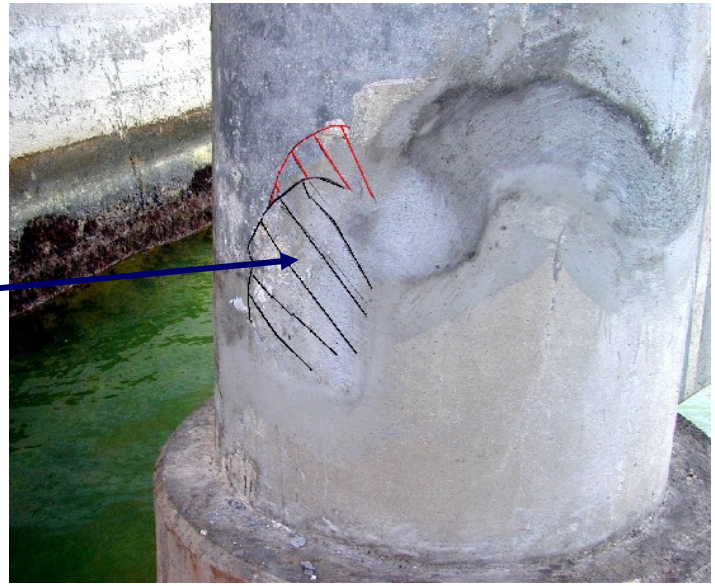
- **EVEN WHEN A GOOD JACKET IS INSTALLED, NEW CORROSION CELLS ARE DEVELOPED AND CORROSION CONTINUES**

CONVENTIONAL REPAIRS ON CHLORIDE CONTAMINATED CONCRETE

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

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

* NCHRP D10-37C



HALLO EFFECT

CONVENTIONAL REPAIRS ON CHLORIDE CONTAMINATED CONCRETE

- IN THE MID 1980’S FDOT DETERMINES THAT CONVENTIONAL REPAIRS WERE NOT ADEQUATE FOR THE PRESERVATION OF CHLORIDE CONTAMINATED STRUCTURES.

FDOT CATHODIC PROTECTION PRACTICES

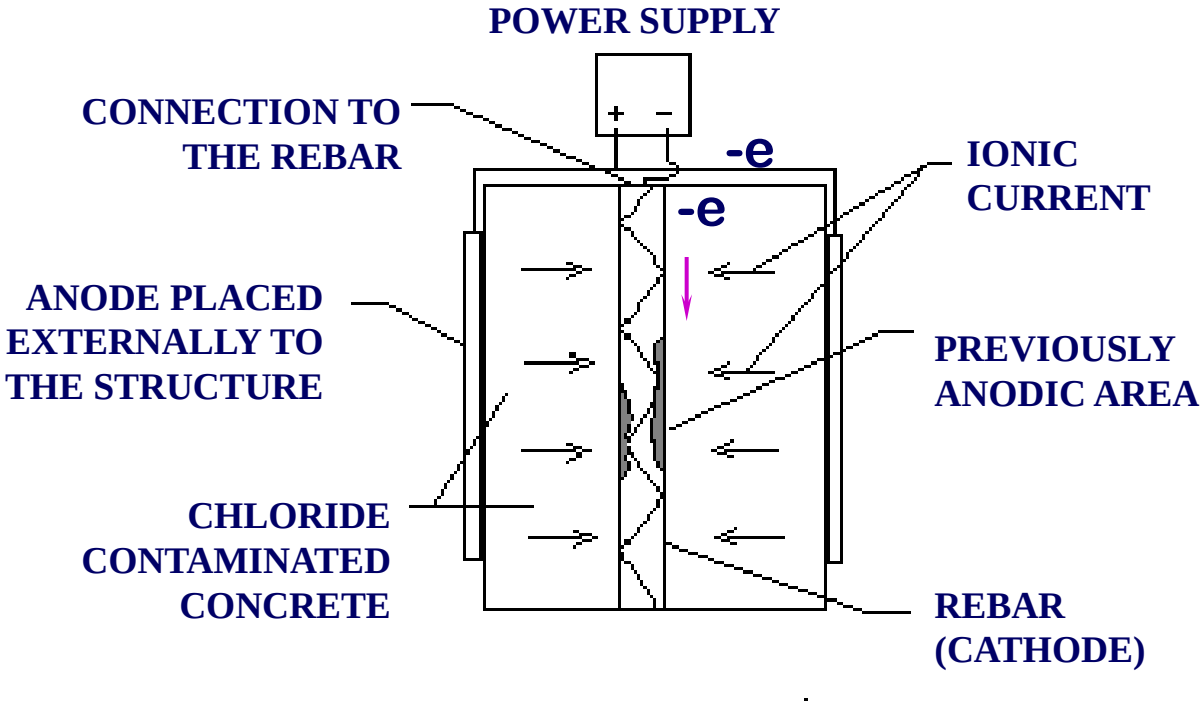
- **TODAY, FDOT APPROACH TO PRESERVE THESE CORROSION AFFECTED BRIDGES IS BASED ON THE CONCEPTS OF CORROSION CONTROL USING CATHODIC PROTECTION ALONG WITH THE REQUIRED CONCRETE REHABILITATION.**

- **GOAL OF PROGRAM: TO PROVIDE AN EXTENSION OF THE SERVICE LIFE OF STRUCTURES AS NEEDED.**

- **OVER 100 BRIDGES IN FLORIDA ARE PROVIDED WITH CATHODIC PROTECTION.**

IMPRESSED CURRENT CATHODIC PROTECTION

Cathodic Protection?



- A SMALL AMOUNT OF CURRENT IS INJECTED TO THE REINFORCEMENT THROUGH THE CONCRETE TO STOP CORROSION.

- TRANSFER OF ELECTRONS FROM THE ANODE TO THE REBAR (CATHODE) IS SIMILAR TO THAT OF A CORROSION CELL.

FDOT CATHODIC PROTECTION PRACTICES

- **IMPLEMENTED IN A BRIDGE BY BRIDGE BASIS.**

  a. No standard specifications have been developed (not a one size fits all item).

  b. Cause and magnitude of corrosion activity is determined prior to the design of the rehabilitation strategy.

  c. Type of cathodic protection determined based on the needs of the particular structure.

FDOT CATHODIC PROTECTION PRACTICES

Highlights of CP Program Implementation:

A) Structural Analysis and Evaluation of Deterioration Required.

B) Rehabilitation of Concrete and Reinforcement is Provided as Needed.

C) Implementation of Corrosion Control Measures:

1. Impressed Current Cathodic Protection.

2. Sacrificial (galvanic) Cathodic Protection.

D) Routine Biannual Inspection of Structure, and Monitoring the Performance of Cathodic Protection Ensures Achieving the Desired Service Life.

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- Ti Ribbon Anode Embedded in Grooves Cut in the Concrete

4- Thermal-Sprayed Zinc Anode in Sacrificial Mode

5- Zinc Mesh Anode in Conventional Pile Jackets

6- Submerged Bulk Anode Systems (Zn, Al or Mg)

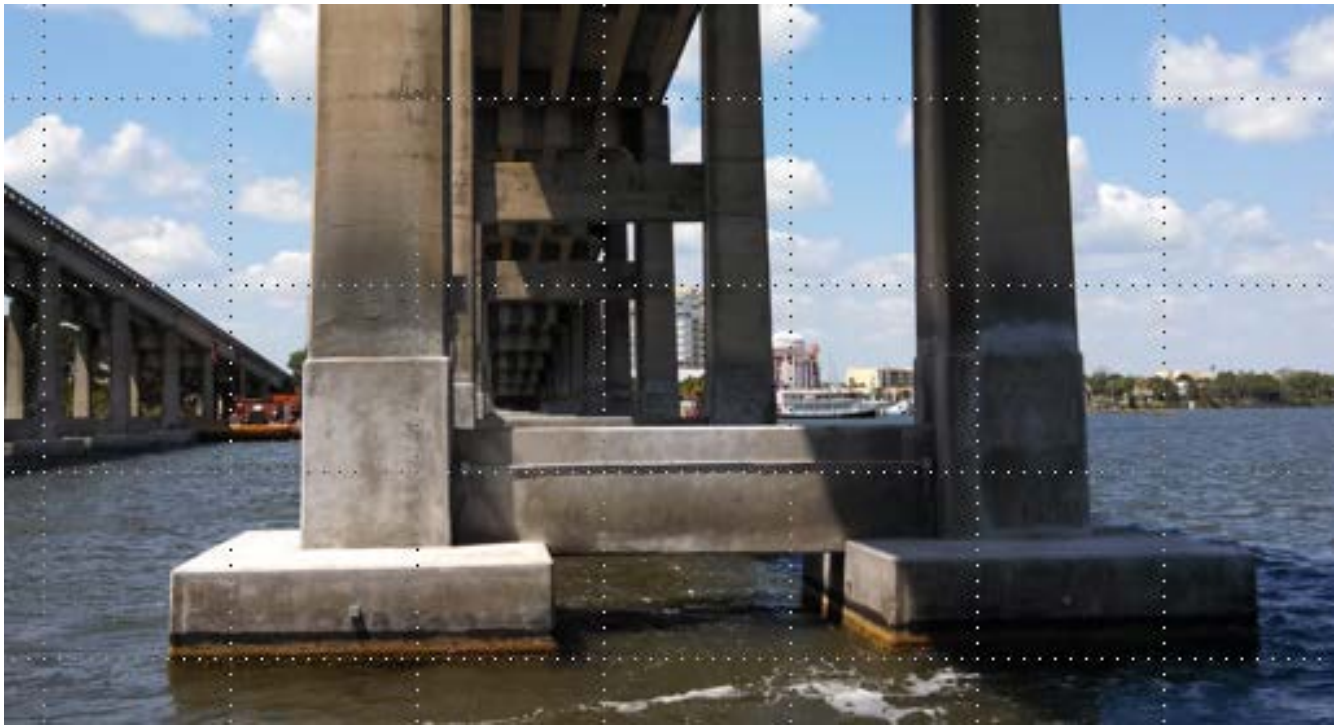
IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

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 OF ANODE WITH MACHINE APPLIED MORTAR (SHOTCRETE) FOR STRUTS AND COLUMNS.

- ENACPSULATION OF ANODE IN STRUCTURAL CONCRETE FOR THE FOOTERS.

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

- **OPTIMIZING THE CP SYSTEM USING NON-METALLIC SUPPLEMENTAL REBAR.**

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH

ENCAPSULATION OF Ti ANODE WITHIN A STANDARD PILE JACKET.

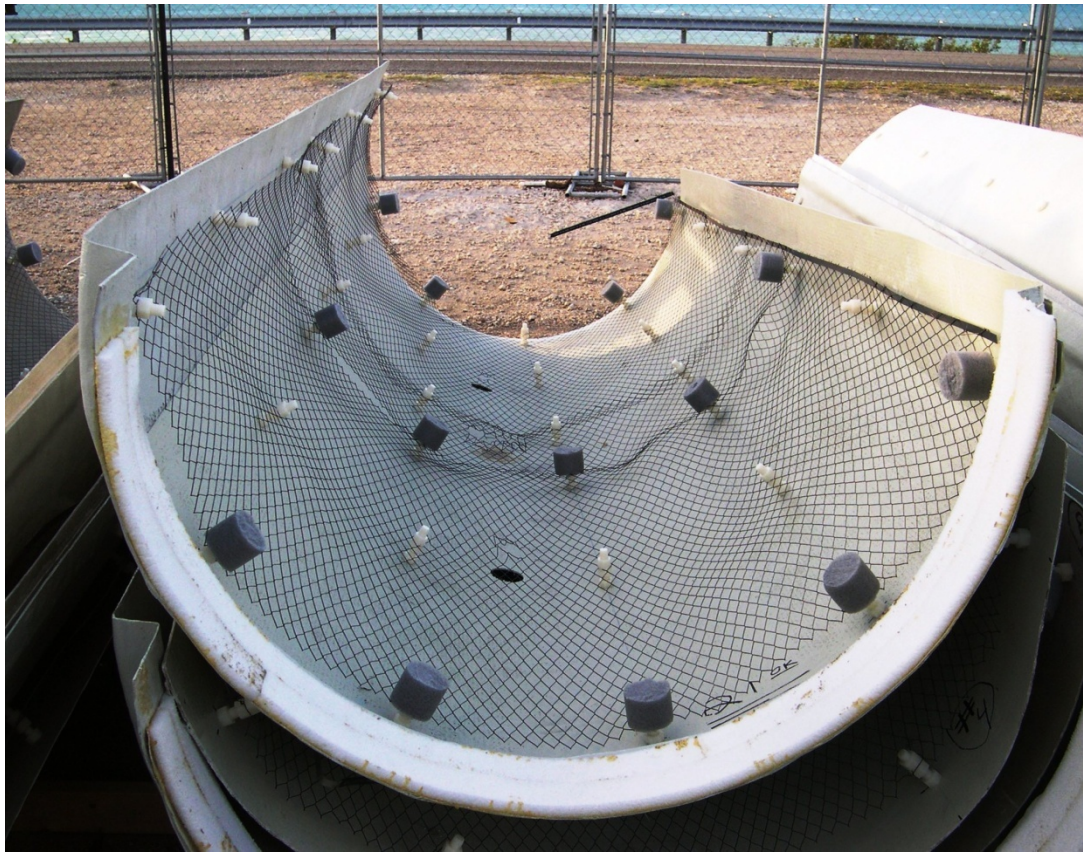
A FIBERGLASS FORM IS PLACED AROUND THE PILE LEAVING AN ANNULAR SPACE BETWEEN PILE AND FORM.

FORM IS FILLED WITH MORTAR/CONCRETE.

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

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE MESH

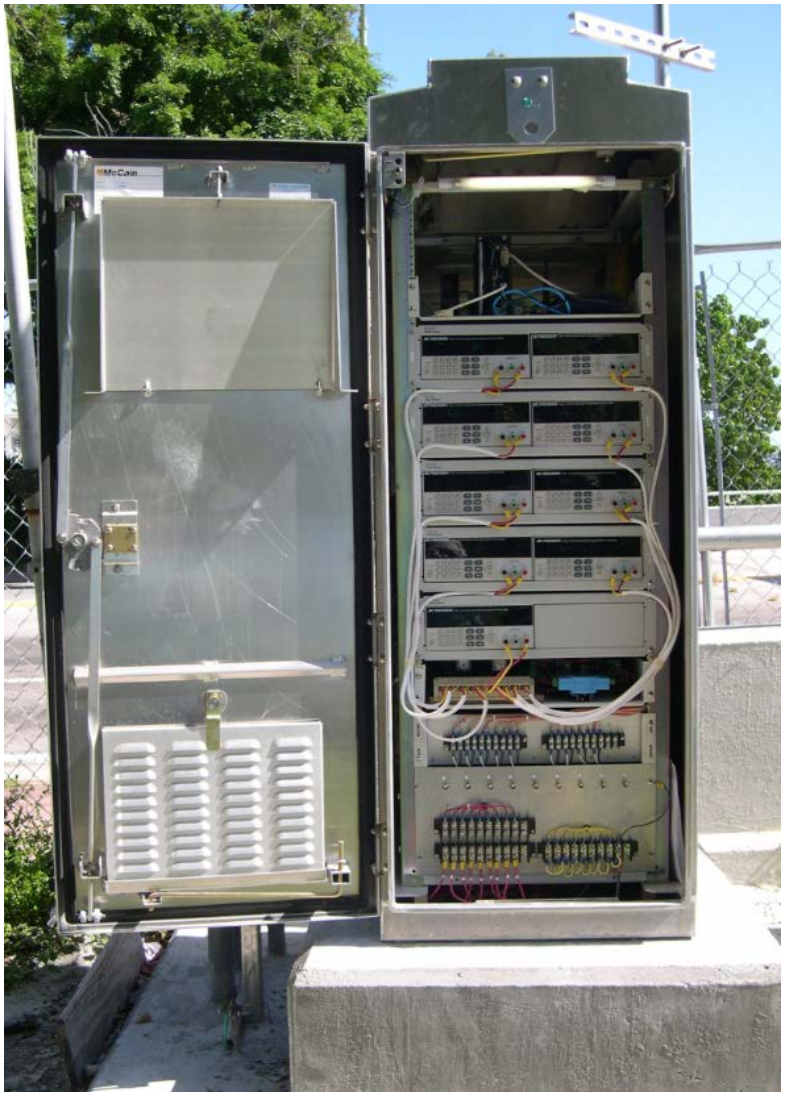


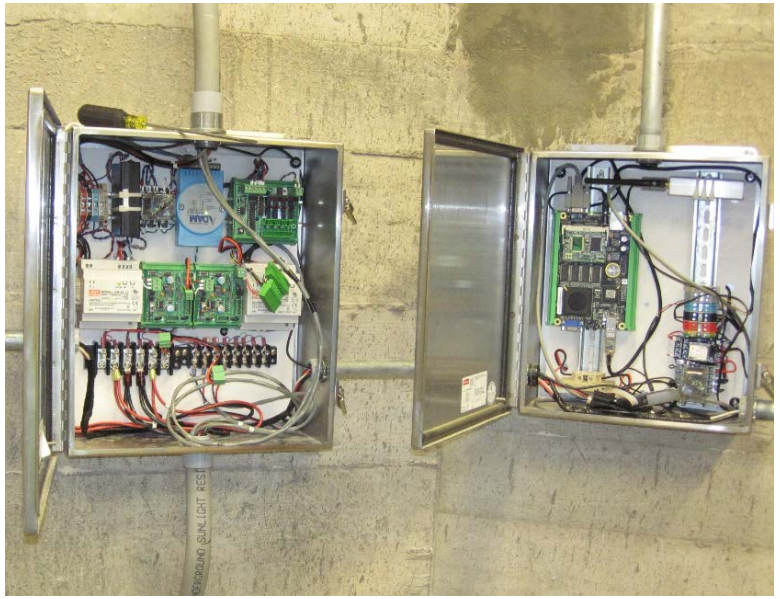
- **THE TITANIUM MESH ANODE IS PRE-INSTALLED INSIDE THE STAY-IN-PLACE FIBERGLASS FORM FOR A CIRCULAR AND SQUARE COLUMNS.**

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT

TITANIUM ANODE RIBBON

IMPRESSED CURRENT CATHODIC PROTECTION CIRCUIT





- **ALL ICCP SYSTEMS ARE PROVIDED WITH TELEMETRY FOR REMOTE MONITORING AND ADJUSTMENTS.**

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

SACRIFICIAL CATHODIC PROTECTION

ARC-SPRAYED ZINC

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

SHOP APPLIED

SACRIFICIAL CATHODIC PROTECTION

ARC-SPRAYED ZINC

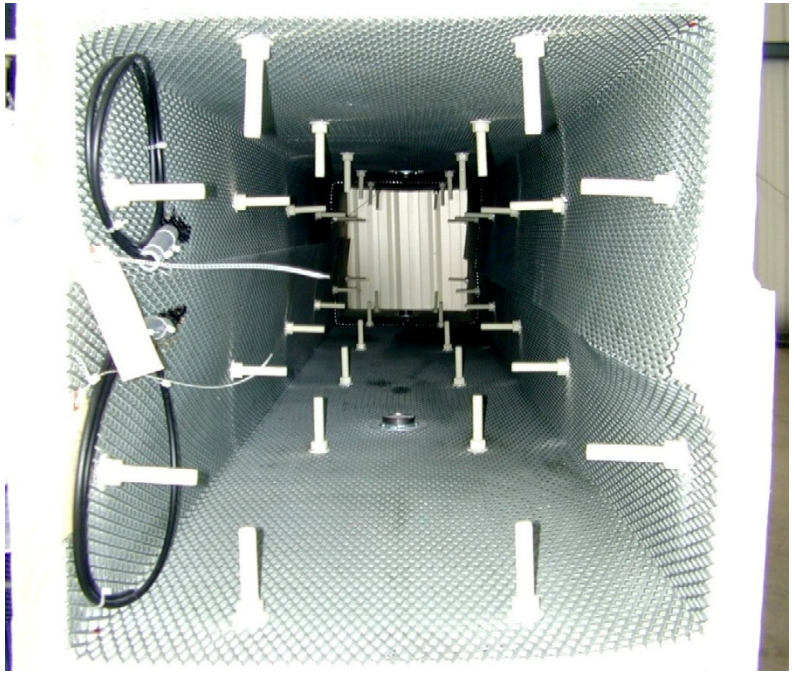
FIELD APPLIED

USED AS A THREE COAT SYSTEM. SPRAYED ZINC OR ALUMINUM ANODE REPLACES THE PRIMER COAT.

SACRIFICIAL CATHODIC PROTECTION

GALVANIC ZINC ANODE PILE JACKETS

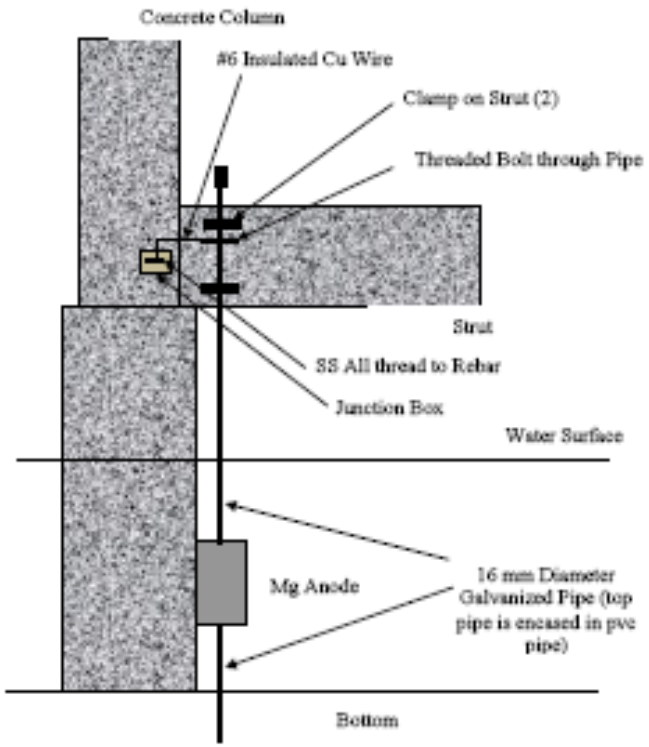
SACRIFICIAL C.P. JACKET IS PLACED AROUND THE PILE AND CONNECTED DIRECTLY TO THE REINFORCEMENT WITHOUT AN EXTERNAL POWER SUPPLY.



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 WAS ESTABLISHED AROUND 1990 AS AN ALTERNATIVE TO CONVENTIONAL REPAIRS.**

- **HAS BEEN A VERY SUCCESSFUL BRIDGE PRESERVATION EFFORT, EXTENDING THE SERVICE LIFE OF BRIDGES IN MARINE ENVIRONMENTS.**

- **THE CATHODIC PROTECTION PROGRAM HAS PROVEN TO BE A COST EFFECTIVE MEANS TO PRESERVE CORROSION AFFECTED STRUCTURES.**

- **THE PROGRAM IS MAINTAINED BY A WORK UNIT SOLELY DEDICATED TO CORROSION AND CATHODIC PROTECTION. CONTINUITY IN MONITORING AND MAINTENANCE OF THE SYSTEMS IS PROVIDED.**

THANKS