

# International Concrete Repair Institute Student Meeting

## Concrete Repair Methods

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District Bridge Engineer District 11-0

October 21, 2010

# Topics

- Philosophy/ Funding
- Types of Treatments for decks, superstructure and substructure, including new technologies.
- Projects (11):
  - SR 3010 Lawrence County
  - SR 2048
  - SR 79-35M Allegheny County
  - SR 51 Allegheny County
  - Commercial Street Allegheny County
  - Westinghouse Bridge Allegheny County
  - McKees Rocks
  - Noblestown Road
  - Liberty Tunnel (Hydrodemo & Latex)
  - Poplar Avenue
  - Tornado Bridge

# Funding

## Funding:

- Maintenance(Betterment)-over \$2,000,000 for bridges
- Capital(regular state/federal allocation, Bond, Act 44 and Economic Stimulus including Interstate) \$43 million/yr to \$200 million/yr (2008 – 2010) plus an additional \$3 million for maintenance. This will drastically drop off after 2011 with out new revenue sources.

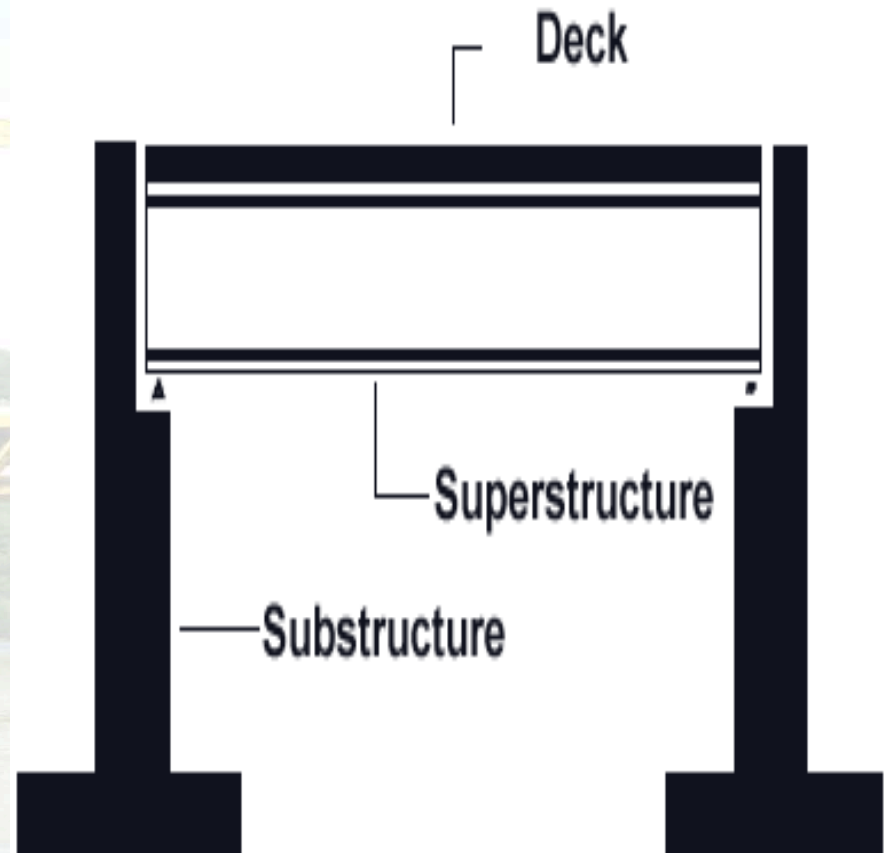
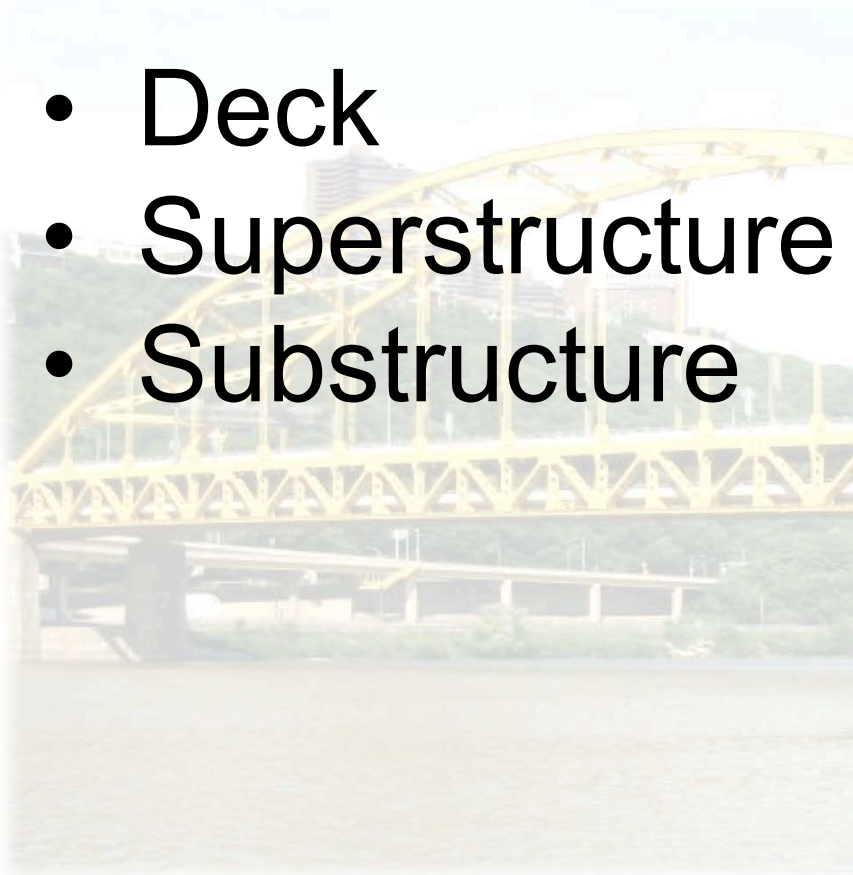
# Philosophy: Right Treatment at the Right Time

- 100 year life and the age of the element
- Group Job-Do as much mileage as possible(bridges- high priority items-repair deck, mill/membrane/overlay(8-10 year treatment)
- Betterment-improving railing, signals, etc-can be supplemented with Bridge Pres funds(8-25 year treatment)
- Interstate/Capital-mill/overlay thru replacement(15 year to 50-deck/100 year treatment for rest of bridge)



# Types of Treatments

- Deck
- Superstructure
- Substructure



# Deck Sounding



# Types of Treatments-Deck

- Cracks
  - Penetrating Sealers- generally penetrates  $\frac{3}{8}$ " -  $\frac{1}{2}$ " into a crack – I79 SB over Campbell's Run, Ft. Duquesne Bridge (latex cracks 2010)
  - Crack Repair (glued) –279 over McKnight Rd, a large number of pop outs, no rebar exposed.

# Types of Treatments-Deck (continued)

- Overlays
  - Thin Overlays (3/8”-1/2”) SR 3010 Lawrence County, I-79 in Allegheny County and Smithfield Street Bridge
  - Mill/Membrane/Overlay Example: I-79 over 19 or Turnpike/ 422 over Business 22
  - Mill/Hydrodemo/Latex-Numerous Projects-79 North of Neville Island(1¼”-5”)
  - Latex competitor -3/4 “ overlay-possible competitor to latex and asphalt-Walkers Mill Rd Bridge in Allegheny Co



# Thin Overlay on SR 3010 Lawrence County





# Milling/Membrane/Overlay for SR 2048





# Milling/Membrane/Overlay for SR 2048 Continued





# SR 79-35M Hydrodemo Continued

Straw catching the dirty water before it goes to the down spout on the edge during the Hydrodemo



Hydro Machine in Action





# SR 79-35M Hydrodemo

## Glenfield Deck After Hydro



## Hydro of Mt. Nebo Bridge





# SR 79-35M Hydrodemo Continued





# SR 79-35M Hydrodemo Continued



The back of the Latex Truck (Sand & Aggregate)



Pouring the Latex

# SR 79-35M Latex Bridge Deck





# SR 79-35M Latex Bridge Deck



Before



After

# Treatments on Superstructures

- Washing
- Repairs to P/S Beams – University of Pittsburgh Study/ Developing Standards-Penoni
- T Beam-Sister beam repairs
- Concrete Arches-typical repair removing deteriorated concrete replacing new concrete by forming/pouring concrete or shotcrete

# SR 60 In Lawrence County

**Before**



**After**



**PHOTO 46 DIRT AND DEBRIS ON BRIDGE SEAT AND HEAVY CORROSION AND RUST ON EXPANSION BEARING MEMBERS AT NORTH ABUTMENT**

**BMS NO. 37 0060 0010 0629  
INSPECTION DATE: 05/14/08**



# Pre-Stress Repair Methods

## Lake View Drive Bridge Collapse December 27, 2005

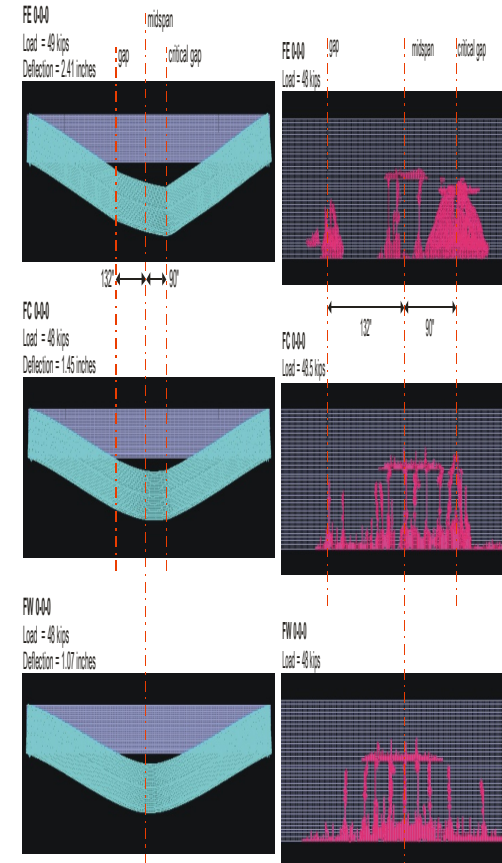
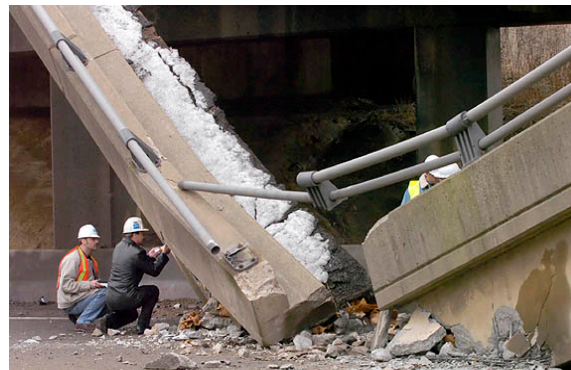
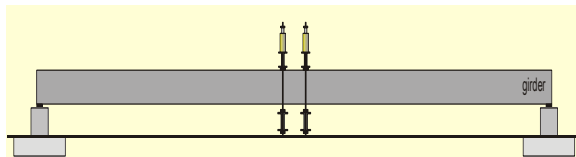
University of Pittsburgh Forensic Study and Test Program:

Testing to failure of two girders recovered from bridge

- Condition assessment
- Material properties
- Extensive AE testing
- Post-test sectioning and re-assessment of condition

Analytical modeling of girders to facilitate improved load rating technique:

- Sections analysis
- 3D FEM modeling





# Repair Methods for Pre-Stressed Concrete Bridges Continued

Review of state of PENNDOT Pre-Stressed concrete inventory

Sources and nature of damage

Review of available repair methods

Development of state-of-the-art repair methods

22 prototype design examples

- 3 girder types
- 4 levels of damage
- 7 repair methods/technologies

Best-practices recommendations

- repair method selection
- modeling techniques

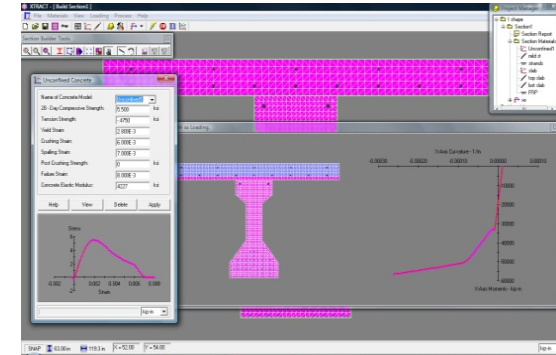
# Repair Methods for Pre-Stressed Concrete Bridges Continued



External Post-Tensioning



Post-Tensioned CFRP



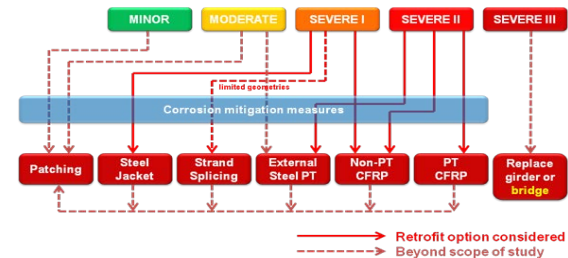
Fiber Section Analysis



Plate-Bonding



Strand Splicing



Repair Method Selection

# Repair Methods for Pre-Stressed Concrete Bridges Continued

Kasan MSCE thesis successfully defended  
January 22, 2009

**Final Report to PennDOT including  
Best-Practices document anticipated  
April 1, 2009.**

Anticipate field implementation in 2010

- Demonstration
- Validation of best practices
- Load-tests to failure

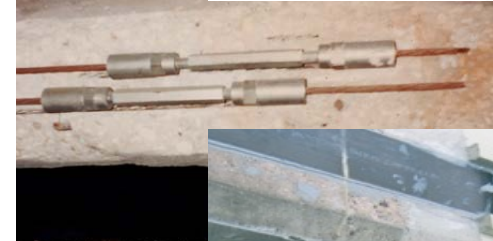


External Post-Tensioning

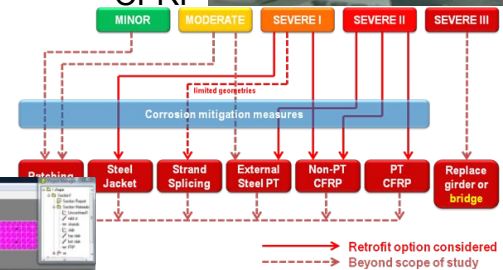
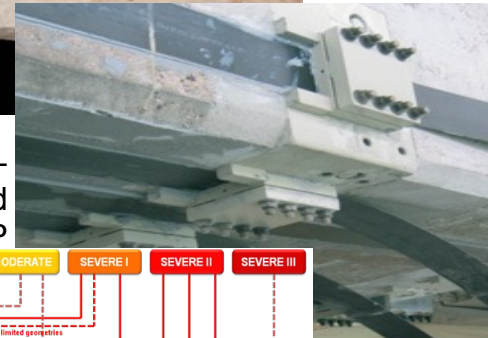
Plate-Bonding



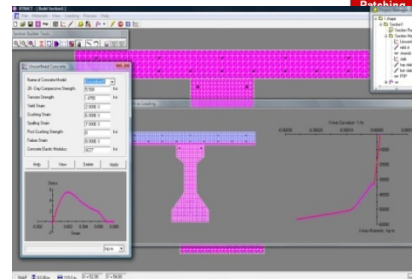
Strand Splicing



Post-Tensioned CFRP

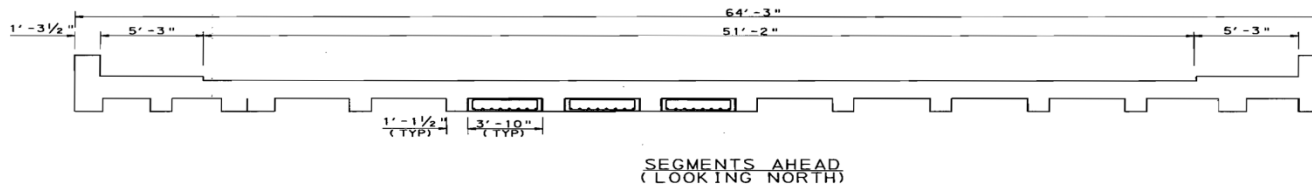


Repair Method Selection



Fiber Section Analysis

# SR 51 Clairton Blvd over Lewis Run Concrete T Beam Repair



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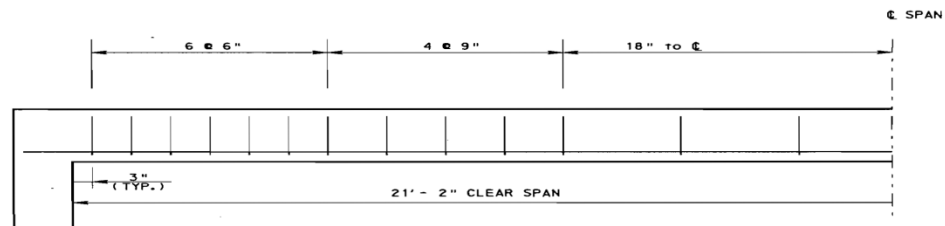
ALLEGENY COUNTY - S. R. 0051  
SEGMENT 0220 OFFSET 0325  
CLAIRTON BLVD OVER LEWIS RUN



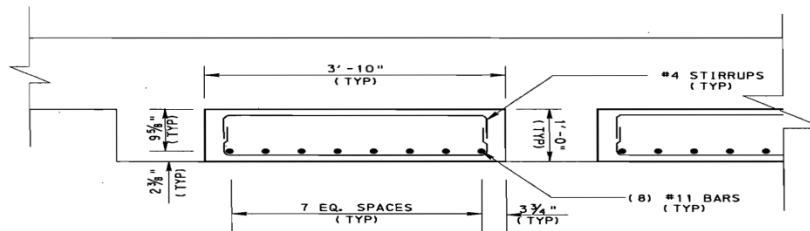
**pennsylvania**  
DEPARTMENT OF TRANSPORTATION

[www.dot.state.pa.us](http://www.dot.state.pa.us)

# SR 51 Clairton Blvd over Lewis Run



BEAM ELEVATION



BEAM DETAIL

ALLEGHENY COUNTY - S.R.0051  
SEGMENT 0220 OFFSET 0325  
CLAIRTON BLVD. OVER LEWIS RUN

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# SR 51 Clairton Blvd over Lewis Run Continued

Before



After



# Commercial Street Bridge Pier



**Before**



# Commercial Street Bridge Arch



After



# Commercial Street Floor Beam



**After cleaning/ Epoxy Coating Steel**

# Westinghouse Bridge



- Extra Concrete Repairs
- Falcons



© Brian E. Small



© Erwin & Peggy Bauer



# Westinghouse Bridge





# Westinghouse Bridge





# Westinghouse Bridge





# Falcons Roosting on Westinghouse Bridge

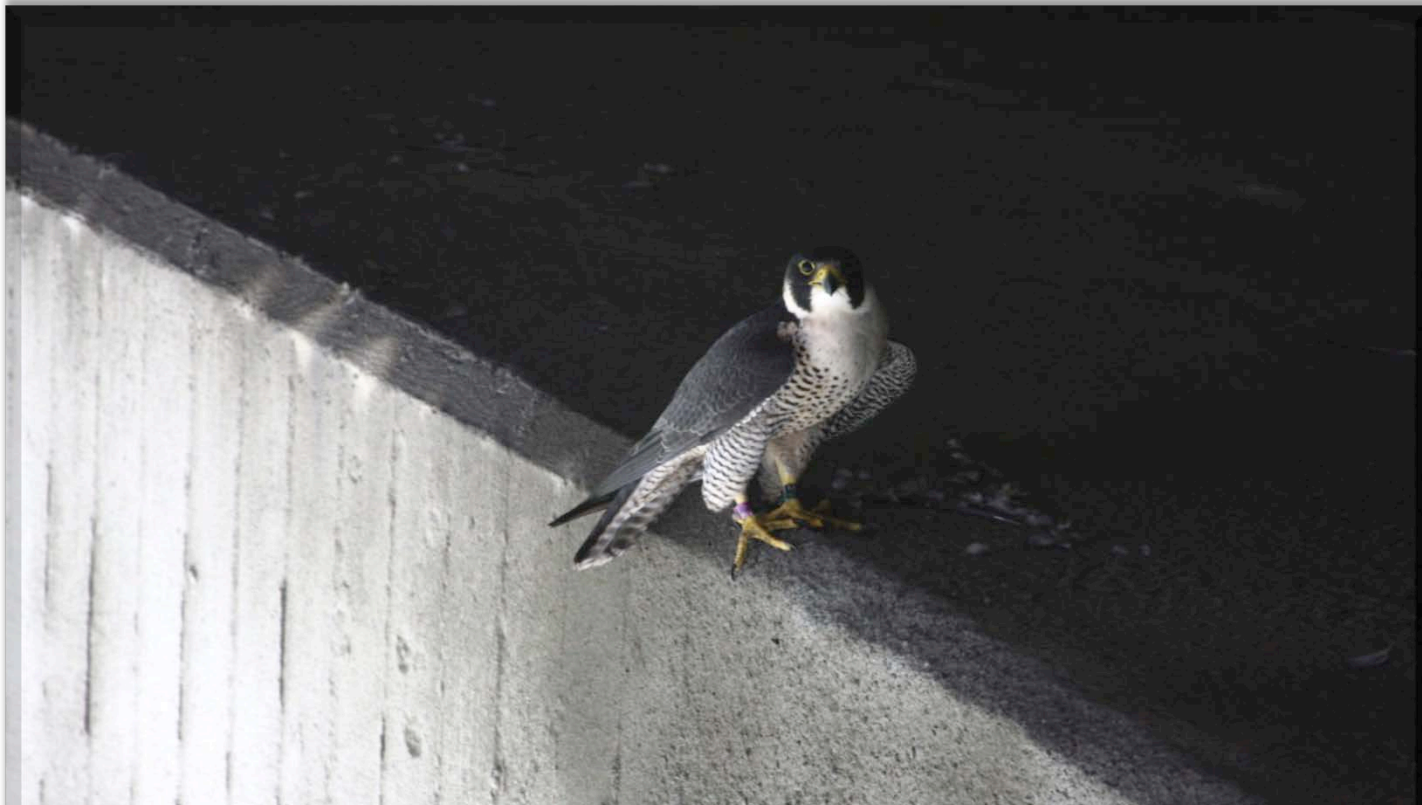


Falcon with her eggs



Falcon guarding her eggs

# Falcons Roosting on Westinghouse Bridge



Falcon sitting on the bridge



# Falcons Roosting on Westinghouse Bridge



Baby Falcons being banded by the Game Commission



Baby Falcons returned to their nest after banding



# McKees Rocks Bridge Sidewalk

- Original Scope
- Hidden Problems
- Results

# McKees Rocks Bridge Sidewalk



NORTH END OF SPAN 11 AT PIER 11  
NOTE: 2' X 6" WIDE SPALL IN WEST  
SIDEWALK



SECTION OF DOWNSTREAM SIDEWALK HAS  
CRACK & IS HEAVED CAUSING A 1 FT RISE &  
CREATING TRIPPING HAZARD @ VERTICAL  
MEMBER 19



MINOR TRIPPING HAZARD OF DOWNSTREAM  
SIDEWALK @ VERTICAL MEMBER 6



# McKees Rocks Bridge ALCOSAN SIPS



# McKees Rocks Bridge ALCOSAN SIPS



# McKees Rocks Bridge ALCOSAN SIP Removal





# Treatment of Substructures

- Typical Repair – replace deteriorated concrete with new concrete with forming /pouring or shotcrete (Noblestown Road and Neville Island).
- Removal with Hydrodemo and repair with shotcrete (Liberty tunnel)
- Adding Galvanic Anodes to Rebar to slow the rate of corrosion
- Application of sealers after repair or after original placement
- Application of Zinc Spray versus sealers to reduce corrosion rates (Poplar Avenue)
- Application of Epoxy Resin to seal piers

# District Executive Memo for Substructure Repair

## Highlights of DEM 2010 - DEM002D

- Proper pre-bid inspection at the right time to the extent and depth of spalls and delaminations.
- Proper quality in plans (bump inspection quantity by 25-50%)
- Proper construction inspections

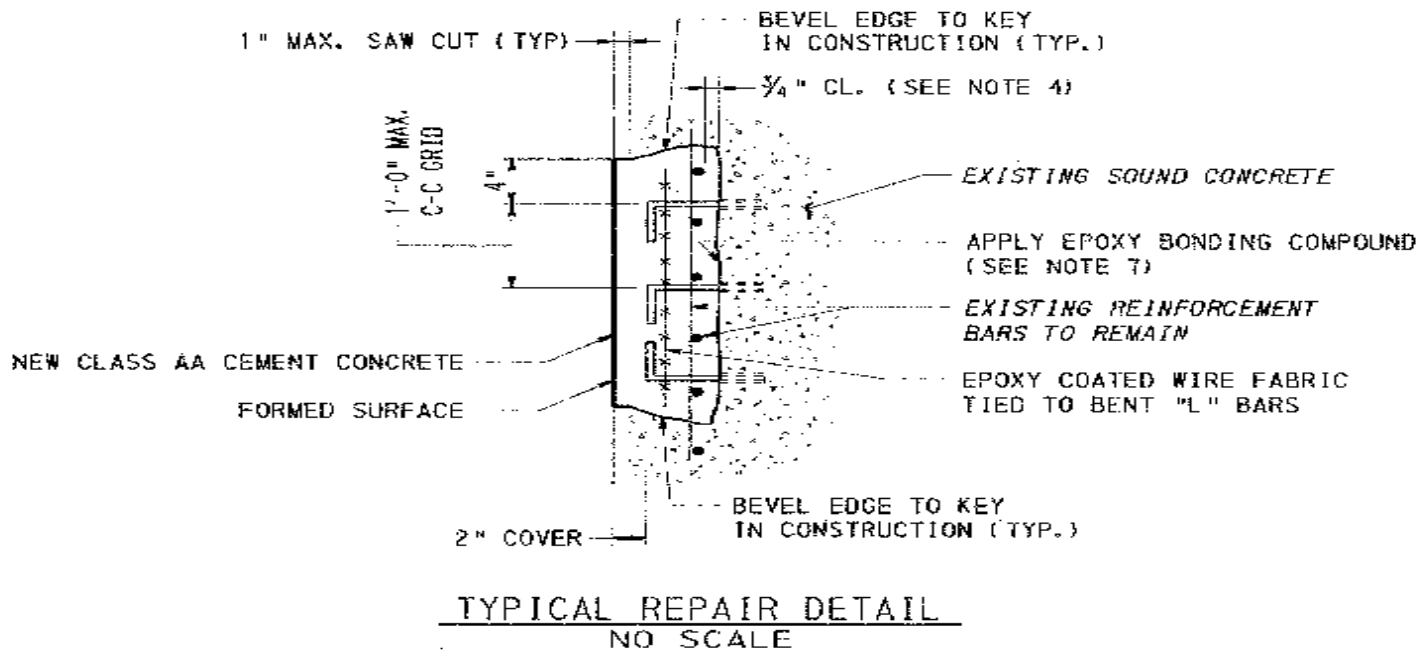
# Substructure Treatments



- Typical concrete spall detail (Noblestown Road)
- Construction sequencing
- Shotcrete (Noblestown Road)



# Noblestown Piers Continued Typical Detail



# Noblestown Piers



# Noblestown Continued



Shotcrete repair



# Liberty Tunnel



1954

- Standard Concrete Repair
- Hydro Demo Repair
- Latest Photos

# Liberty Tunnel Hydrodemo & Latex of Ceiling





# Liberty Tunnel Hydrodemo





# Liberty Tunnel Shotcrete of Ceiling



# Liberty Tunnel

In Bound on the South Hills Side





# Liberty Tunnel

In Bound on the South Hills Side near the center of the tunnel





# Liberty Tunnel

In Bound on the City Side



# Liberty Tunnel

In Bound City Side



# Dry and Wet Shotcrete Process

- **Shotcrete is not a special product.**
- **It is a method of placing a concrete mix.**
- Special additives can modify the properties and durability of the final product such as adding polymer fiber reinforcement.
- Shotcrete may be applied to surfaces using a dry or wet-mix method.
- The wet-mix concrete method consists of portland cement and aggregate premixed with water before the pump pushes the mixture through the hose.
- Additional compressed air is added at the nozzle to increase the velocity of the mixture.
- In the dry-mix process, compressed air propels a premixed blend of portland cement and damp aggregate through the hose to the nozzle. Generally, the shotcrete gun nozzle is held at a right angle 2 to 6 feet from the surface. In most cases, shotcrete can be deposited in the required thickness in a single application.
- For some vertical and overhead applications and for some smooth finishes, shotcrete must be applied in 1 to 2-inch (2.5 to 5 cm) thick layers.
- **Once shotcrete is placed, it can be finished in a variety of methods, including natural, flash coat finish, broom finish, various rough trowel finishes, and smooth steel trowel finish. After finishing, the concrete must be cured for a period of at least seven days.**



# Dry and Wet Shotcrete Process Continued

- The application of shotcrete can be done successfully with either dry or wet method. The dry-mix shotcrete process tends to be more favorable for lower volume placements. **We have been favoring the dry method lately.**
- It is also a more flexible method, allowing for more frequent relocations of equipment.
- Equipment is more easily cleaned at the end of the placement. The nozzle man must exercise great care in adding the necessary amount of water while shooting.
- **The certified nozzle man does not have to be concerned with controlling the water addition. The wet shotcrete mixture has a limited “pot-life.”**
- Proper placement is the most important element in achieving good shotcrete results.
- Most defects that occur in shotcrete are due to poor placement.
- The nozzle man's goal is to achieve adequate compaction and good encasement of the reinforcement (if present) with no entrapped rebound or hardened overspray.

# New Technologies

- Hockey Pucks-Tornado and SR 60
- Performance to date?
- Zinc Spray (Poplar Avenue)

# New Technologies Continued





# Finished Concrete Repair using Galvanic Anodes (18-33B) Tornado Bridge



**THANK YOU**  
**QUESTIONS ?**

