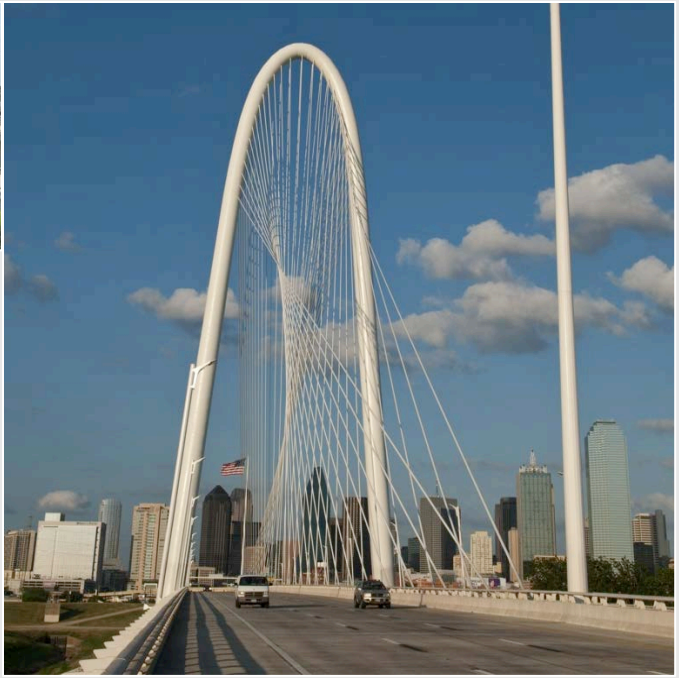


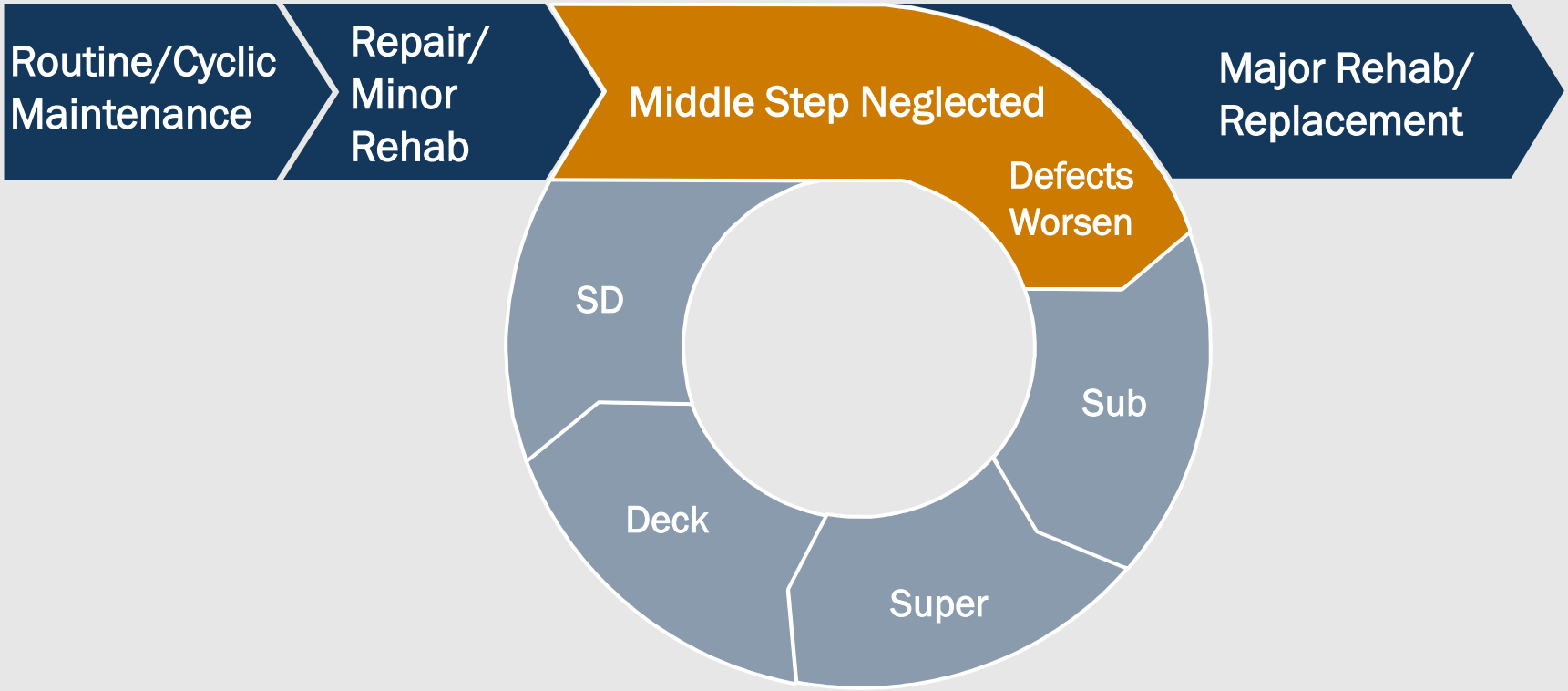



BEEFING UP DETERIORATING BRIDGE DECKS

Graham Bettis, P.E.

TxDOT Bridge Division

Bridge Asset Management



What We're Trying to Avoid – Super and Substructures

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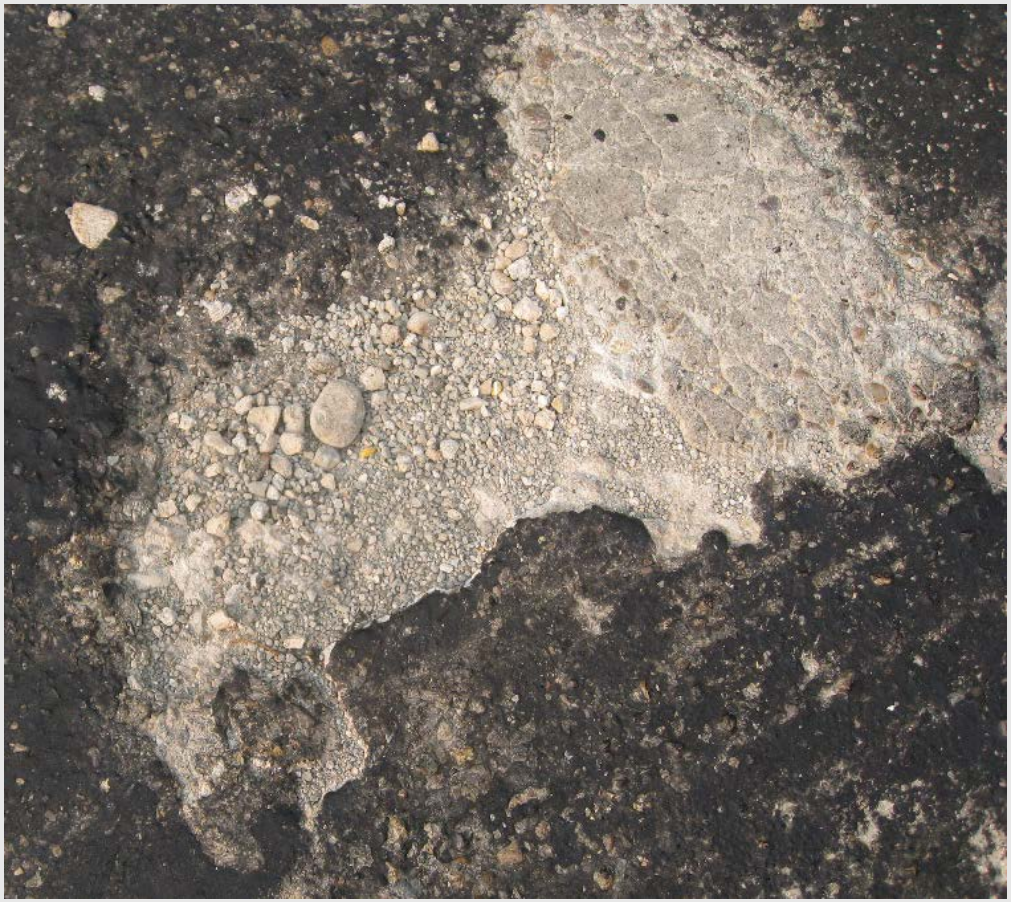
What We're Trying to Avoid – Super and Substructures

Bridge Decks in Texas

- 14,000 On-System Bridges (40% of Inventory) Constructed between 1950 and 1970
- Varying Deck Thicknesses in Different Eras/Bridge Types
- Deteriorated for Variety of Reasons
  - Age
  - Corrosion
  - Reinforcement Detailing

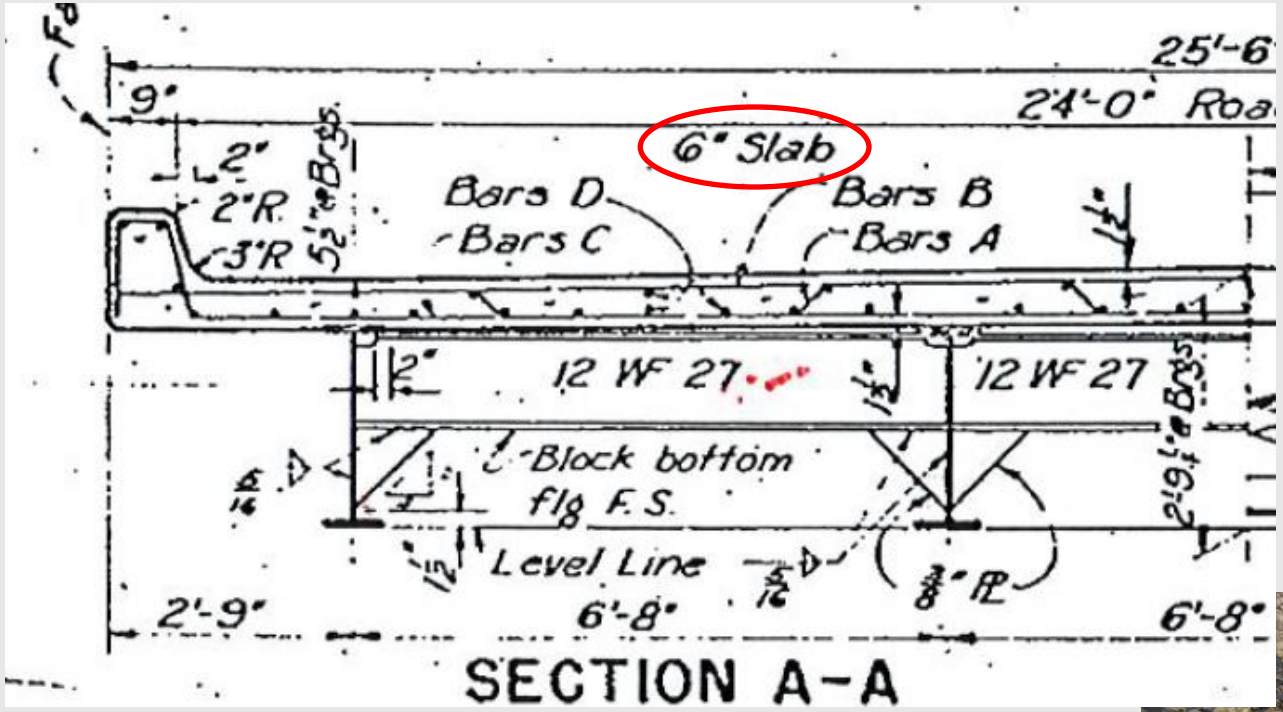
Severe Deck Deterioration

Severe Deck Deterioration

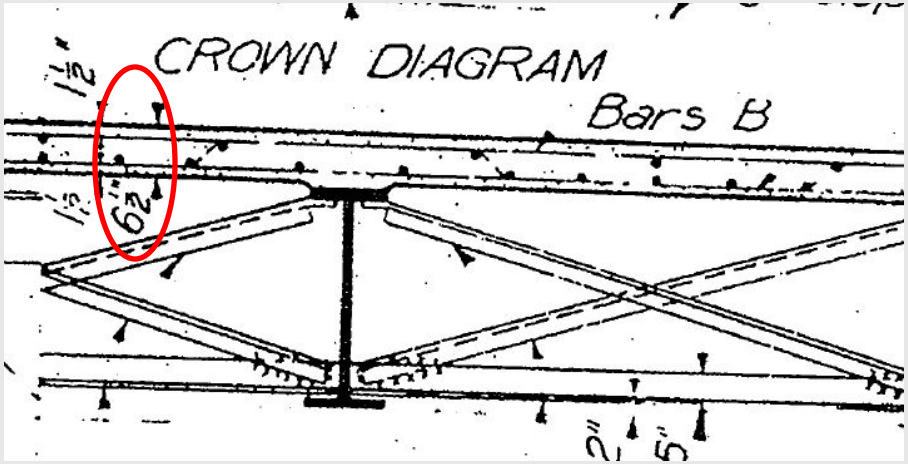


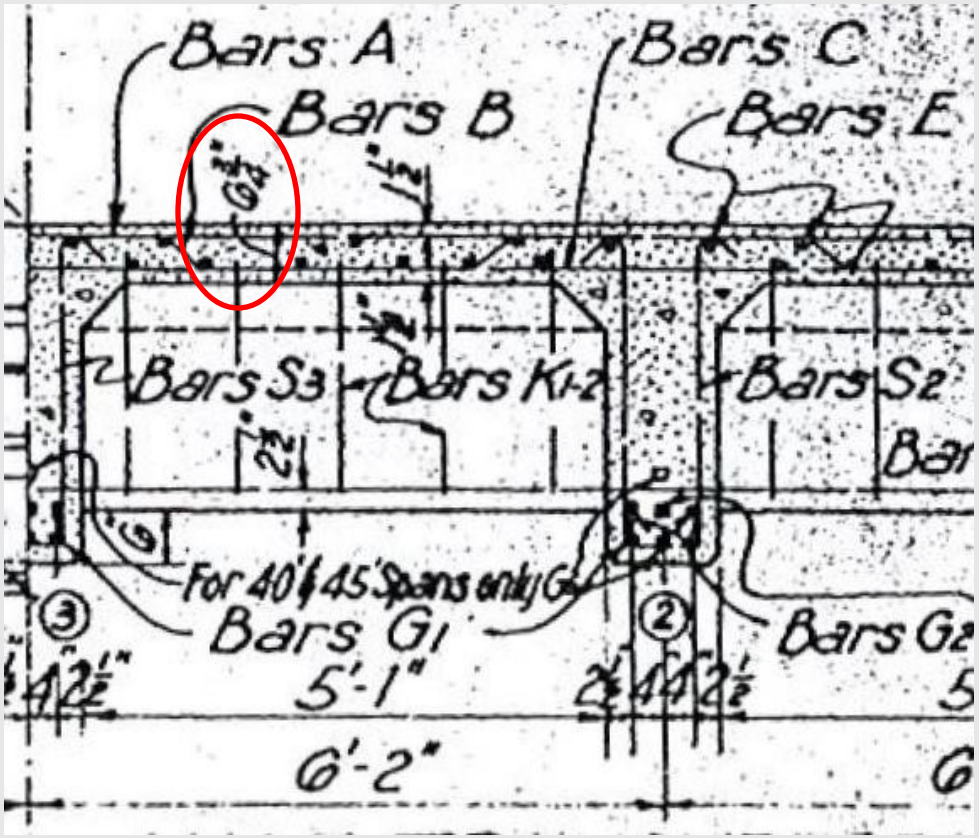
Severe Deck Deterioration

Six Inch Decks

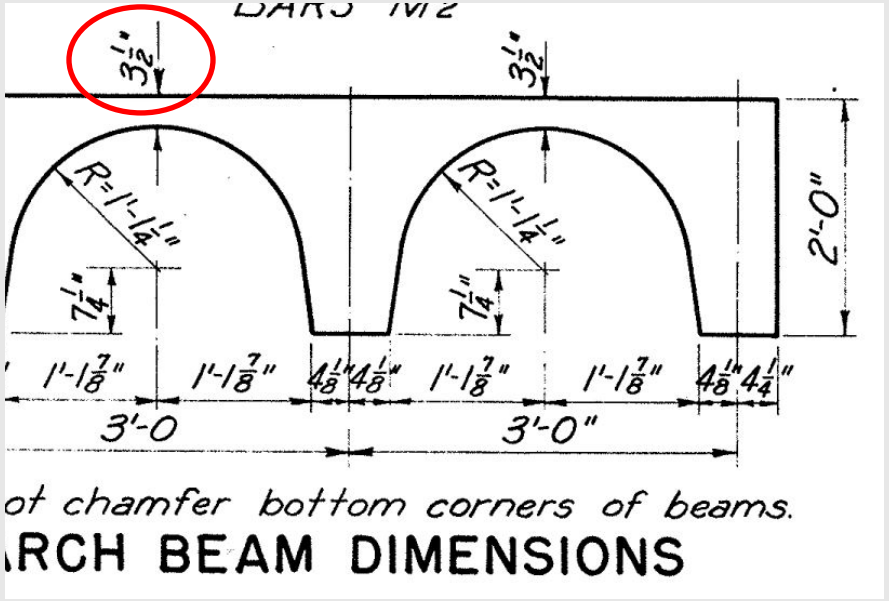


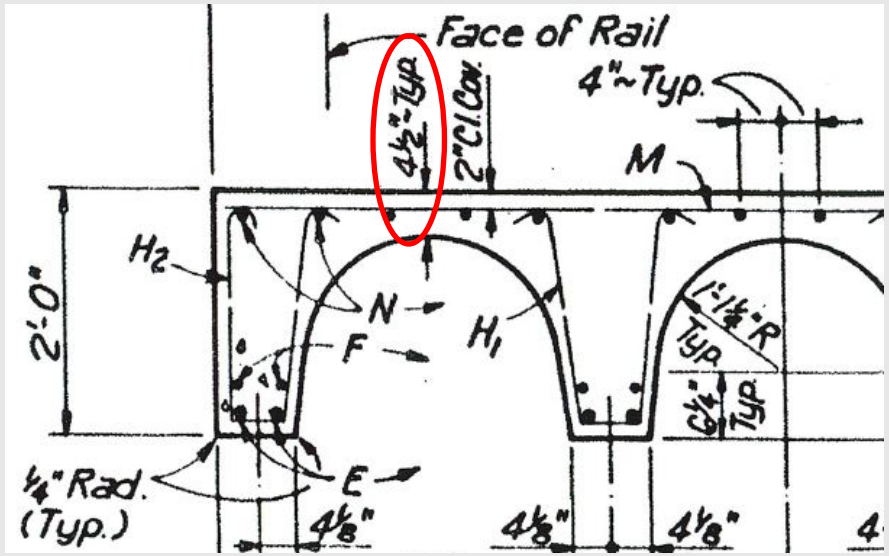
Thin Bridge Decks + Age = Map Cracking





Pan Girder Bridges – Thin Crowns





Pan Girder Bridges – Thin Crowns

Rehabilitation Approach

- Identify Bridges with Deteriorated Decks but “Good” or “Fair +” Substructures and Superstructures
- Bridge Deck Condition Ratings
  - 1,000,000 SF Rating <=4
  - 15,000,000 SF Rating = 5
- In Total, Estimated $170M in Deck Replacement and $80M in Deck Rehabilitation
- Ten-Year Plan

Identifying Bridge Deck Damage

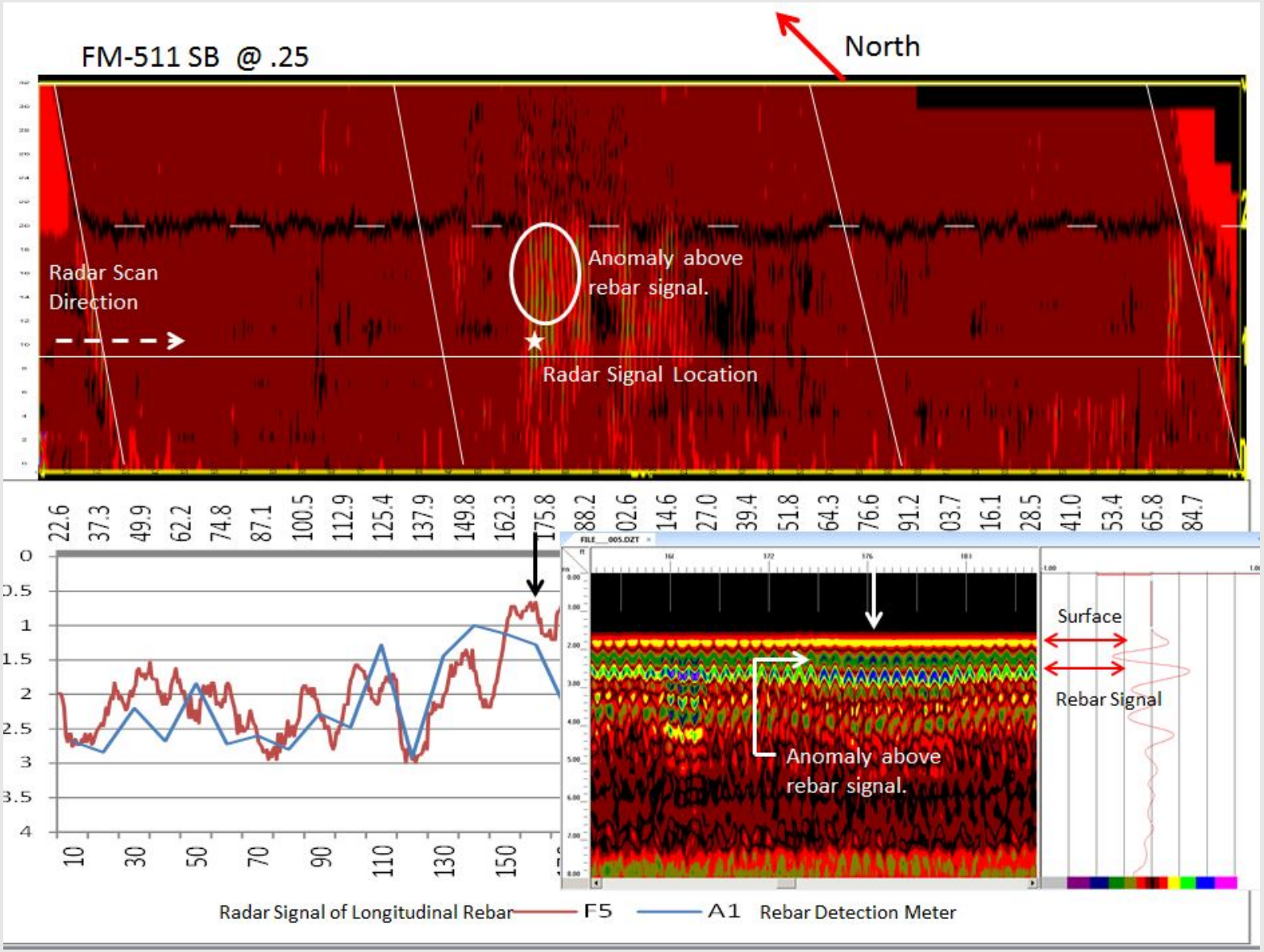
- Visual
- Nondestructive Evaluation
  - Sounding
  - Ground Penetrating Radar
  - Impact Echo
  - Infared Thermal Imaging

Sounding

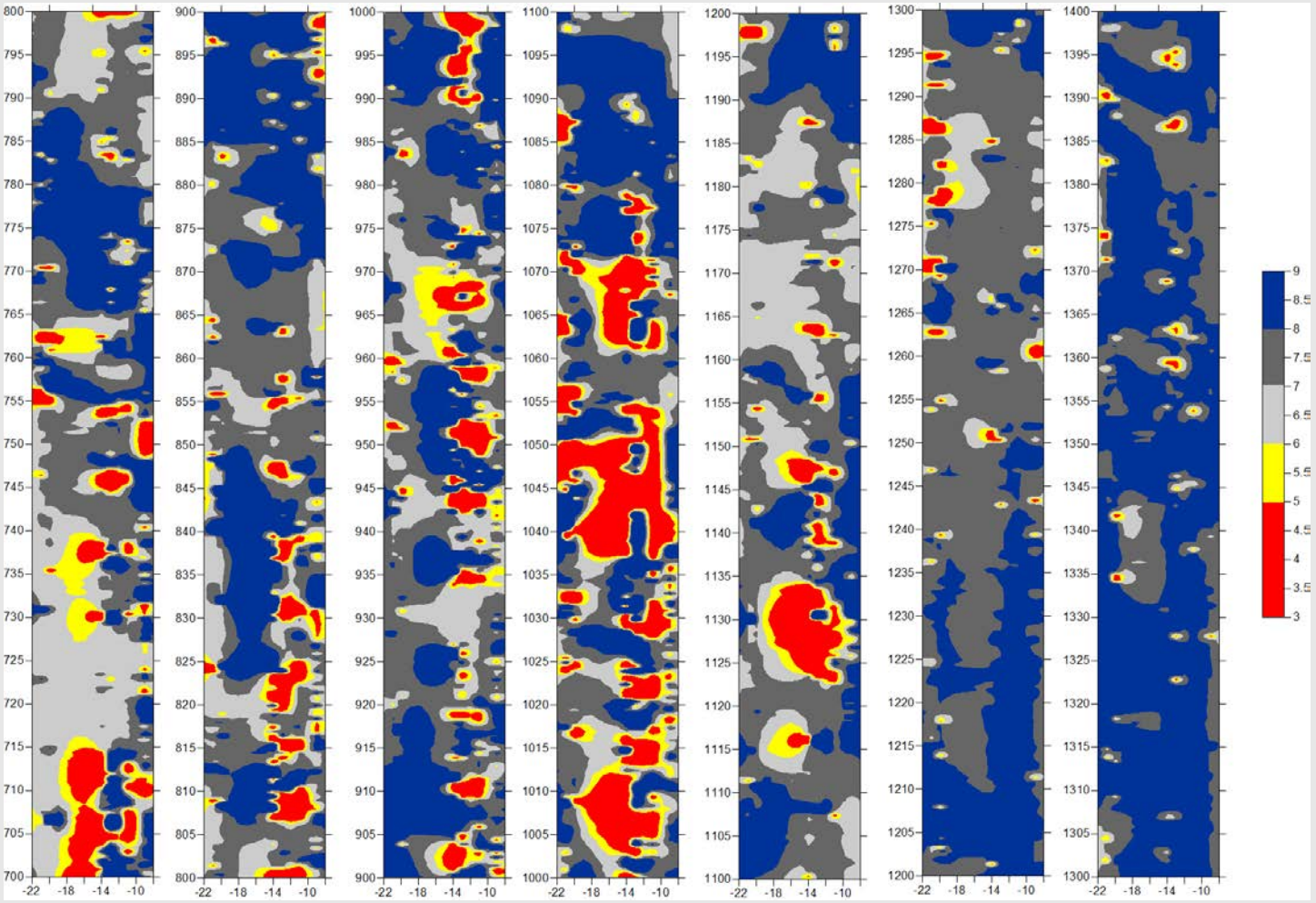
Courtesy: Rutgers University

Ground Penetrating Radar

Ground Penetrating Radar



Impact Echo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1000 995 990 985 980 975 970 965 960 955 950 945 940 935 930 925 920 915 910 905 900
1100 1095 1090 1085 1080 1075 1070 1065 1060 1055 1050 1045 1040 1035 1030 1025 1020 1015 1010 1005 1000
1200 1195 1190 1185 1180 1175 1170 1165 1160 1155 1150 1145 1140 1135 1130 1125 1120 1115 1110 1105 1100
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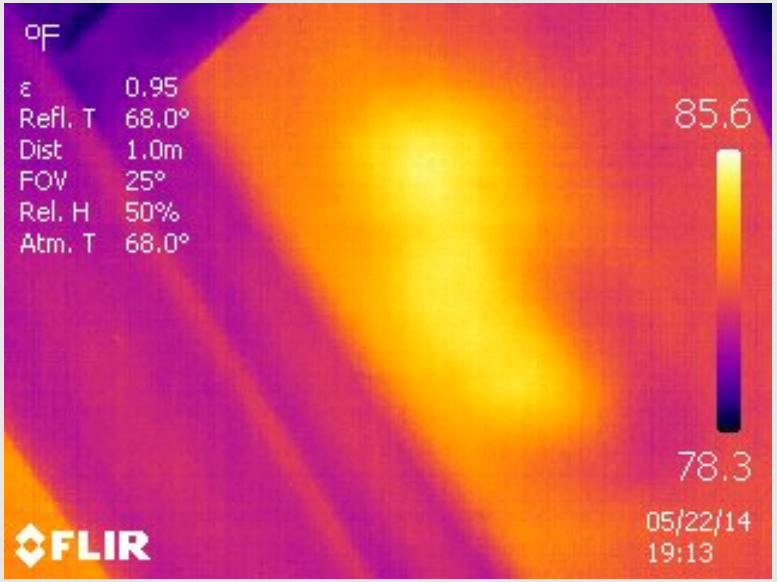
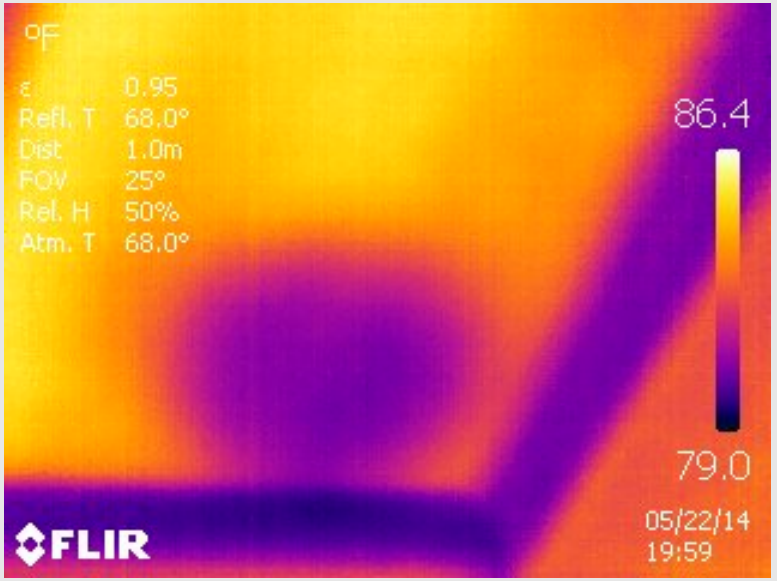
Infared Thermal Imaging





Infared Thermal Imaging

FHWA LTBP and Nondestructive Evaluation

RABIT Bridge Deck Assessment Tool

- Panoramic Camera
- High-Definition Imaging
- Electrical Resistivity Probes
- Impact Echo
- Ultrasonic Surface Waves
- Ground Penetrating Radar
- Global Positioning System

Courtesy: FHWA Research and Technology

Degrees of Damage

- Non-Structural
  - Isolated Cracking
  - Widespread Cracking
  - Uniform Wearing
- Structural
  - Rehab vs. Replace

Cracking

- Crack Sealing
  - Low-viscosity, gravity-fed
  - TxDOT maintains list of preapproved materials
- Discrete Crack Sealing
  - Multiple brush applications
  - Effective but expensive and time consuming
- Widespread Cracking
  - Apply using squeegee or wet-nap roller
  - Add coarse sand
  - Grooves can be problematic

Uniform Wearing

- Structurally sound but waterproofing layer necessary (e.g. cover compromised)
- Multi-Layer Polymer Overlay
  - Crack Sealant
  - Aggregate
  - Resin
- Preapproved MLPO Material
  - Epoxy/Modified Epoxy
  - Methacrylate
  - Other Polymers

Uses for Multi-Layer Polymer Overlay

Spot-Applied Polymer Overlay

Structural Overlay

- TxDOT Specs include two mix designs:
  - CO = Bridge Deck Concrete Overlay
  - LMO = Latex-Modified Concrete Overlay
- Thickness
  - 1.25” to 1.5” Minimum for LMO
  - Thicker (2”) preferable to minimize likelihood of delamination
- Surface Prep
  - Roughened surface to promote mechanical bond
  - Clean, saturated-surface dry
  - No grout or polymer bonding agents

Structural Overlay

- Concrete Overlay Mix
  - Low W/C
  - Smaller Coarse Aggregate
  - Works particularly well in thick applications (e.g. mechanical tie via reinforcing cage)
- Latex-Modified
  - Very Low Permeability
  - Lower Modulus of Elasticity than Plain Concrete
  - Less Stringent Curing (Faster Turnaround)
  - Effective but Can Be Expensive

Structural Overlay Application

- Milling Asphalt
  - Don’t combine with concrete milling
- Milling Concrete
  - Constant depth
- Shot Blasting
  - Surface prep for removal to or above reinforcing layer
  - Remaining concrete is sound
- Hydro-demolition
  - Highly effective
  - Calibrated to remove specified depth
  - Locates unsound concrete
  - Excellent surface prep
  - Very expensive

Existing Bridge Deck

All photos courtesy of Hydro-Technologies

Milling

Concrete Deck after Milling

Hydro-Demolition

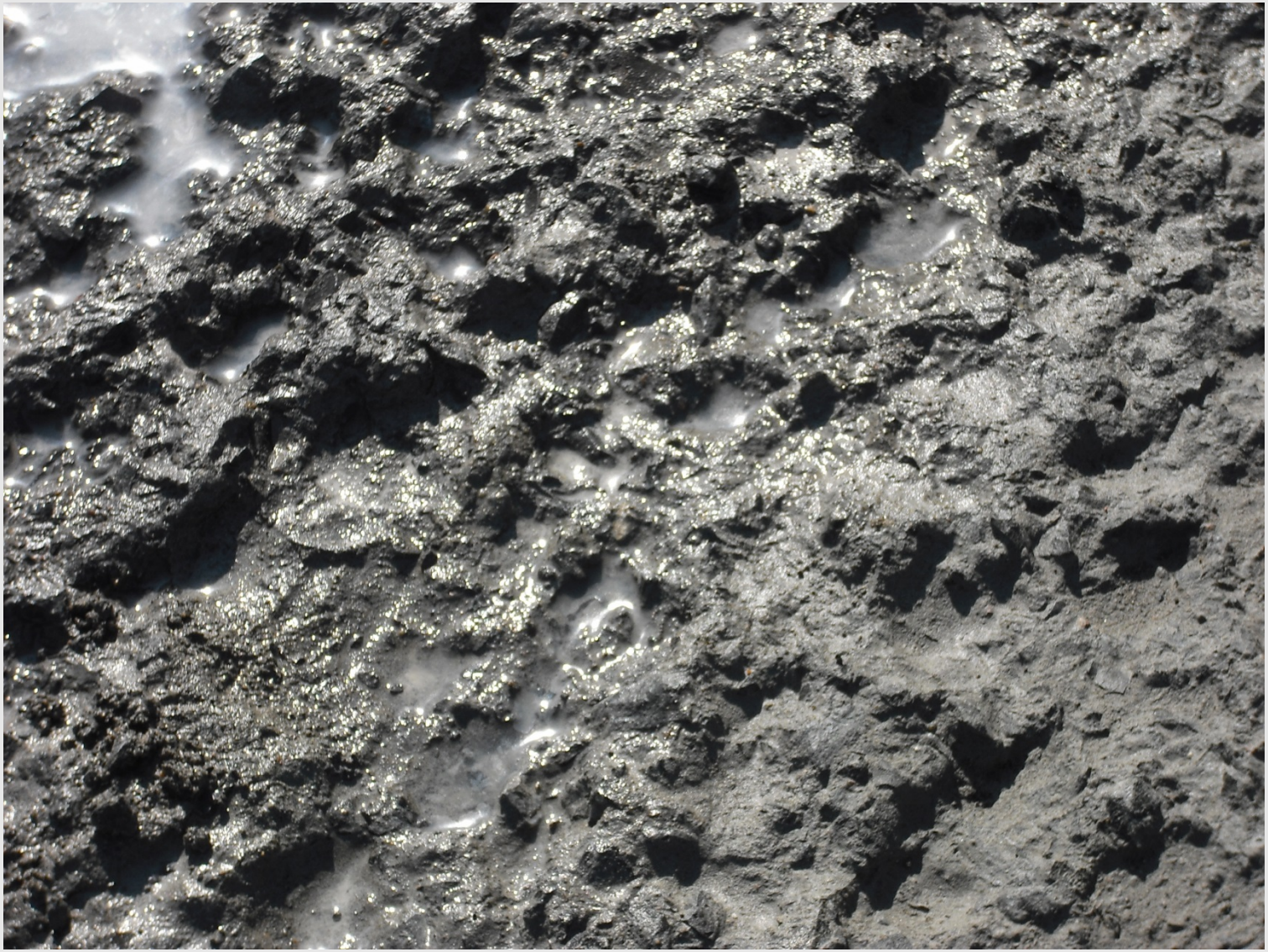
Hydro-Demolition

Hydro-Demolition Test Area

Vacuum Cleanup after Hydro-Demolition

Cleaned Deck

Cleaned Deck/Prepared Surface



Latex-Modified Overlay Placement

Completed Overlay

Bridge Deck Rehab vs. Replace

- Sometimes deck replacement not feasible
  - Must maintain traffic
  - Girder layout prevents phasing
  - Lack of detour

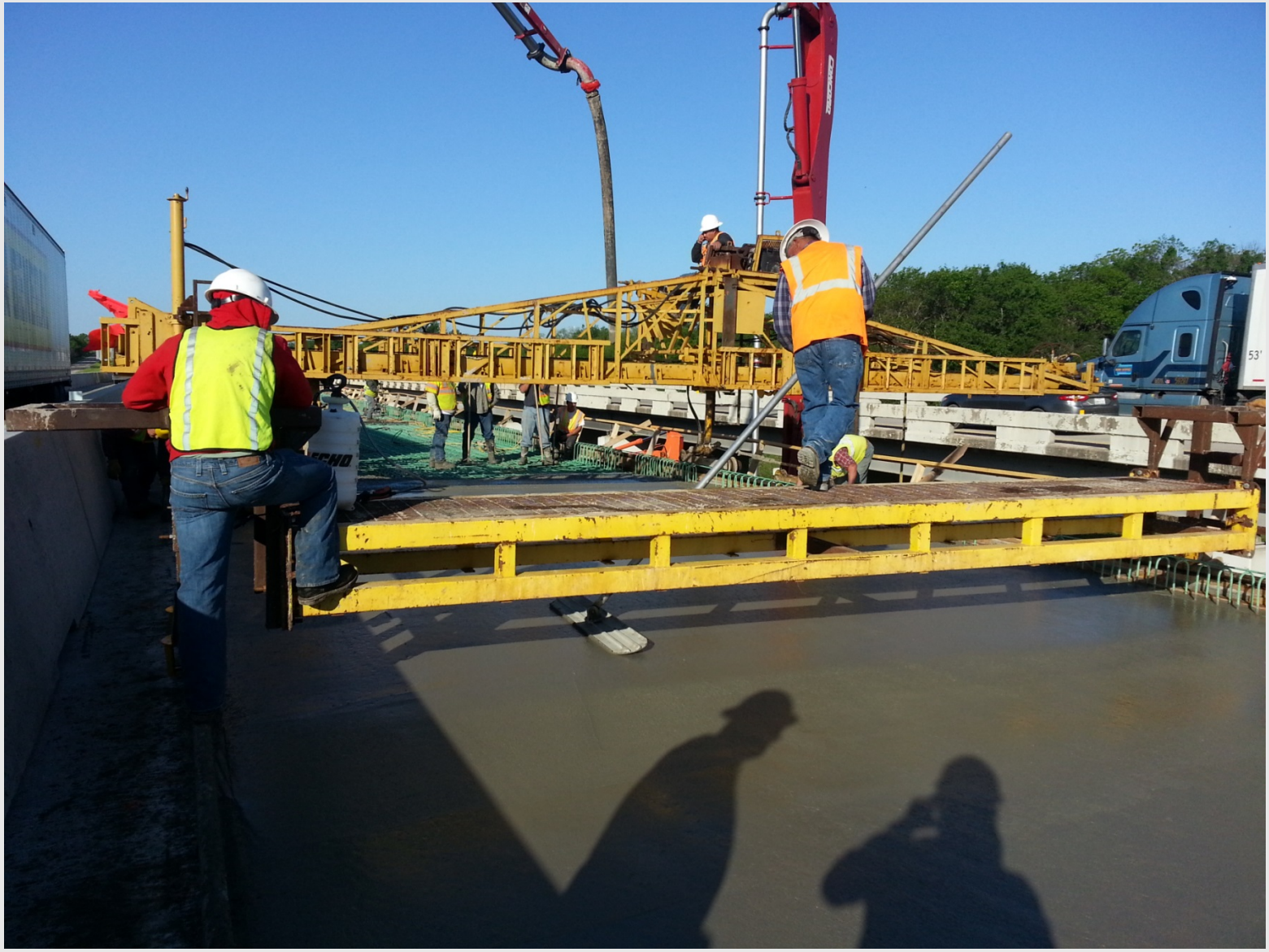
Bridge Deck Rehab vs. Replace

Bridge Deck Replacement – Steel Cleaning/Painting

Bridge Deck Replacement – Making Girders Composite

Bridge Deck Replacement

Bridge Deck Replacement



Bridge Deck Replacement

Cost

- Surface Preparation
  - ACP Removal: $3/SY
  - Milling: $5 - $10/SY
  - Shot Blasting: $3 - $5/SY
  - Hydro-Demolition: TBD in Texas but currently $60 - $80/SY
- Overlay
  - MLPO: $30 - $40/SY
  - 2” Concrete Overlay: $60 - $80/SY
  - 4” Concrete Overlay: $120/SY
  - 1.5” Latex-Modified Overlay: $130/SY
  - 3” Latex-Modified Overlay: $160/SY
- Bridge Deck Replacement: $250 - $300/SY

New Bridge Deck Construction

- Long-term preservation centers around designing and building largely maintenance-free structures
- For Bridge Decks:
  - High quality concrete
  - Thicker deck, increased cover
  - Hot and cold weather provisions
  - Curing (8 days minimum)
  - Contractor responsible for addressing cracks and other defects
- No asphalt overlays!
  - Reduces capacity by adding dead load
  - Holds moisture and other contaminants against concrete
  - Reduces rail height
  - Creates debris on caps

Asphalt on Bridge Decks

Asphalt on Bridge Decks

Asphalt on Bridge Decks

Asphalt on Bridge Decks

QUESTIONS?

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