BEEFING UP DETERIORATING BRIDGE DECKS

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Bridge Asset Management

Routine/Cyclic Maintenance → Repair/Minor Rehab → Middle Step Neglected → Major Rehab/Replacement

- Defects Worsen
- SD
- Sub
- Deck
- Super
What We’re Trying to Avoid – Super and Substructures
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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

ARCH BEAM DIMENSIONS

Face of Rail 4" Typ.

H2

N

E

H1

4½" Rad. (Typ.)

4½" 4½"

4½"

2'-2"

2'-0"

2' Cl.Cm.

M

1½" R Typ.

4½"

4½" 4½" 4½"
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
  - Infrared Thermal Imaging
Sounding

Courtesy: Rutgers University
Ground Penetrating Radar
Ground Penetrating Radar

FM-511 SB @ .25

North

Radar Scan Direction

Anomaly above rebar signal.

Radar Signal Location

Anomaly above rebar signal.

Surface

Rebar Signal

Radar Signal of Longitudinal Rebar

F5  A1  Rebar Detection Meter
Impact Echo
Infared Thermal Imaging
Infared Thermal Imaging

\begin{align*}
\text{ε} &= 0.95 \\
\text{Refl. T} &= 66.0^\circ \\
\text{Dist} &= 1.0m \\
\text{FOV} &= 25^\circ \\
\text{Rel. H} &= 50\% \\
\text{Atm. T} &= 68.0^\circ \\
\end{align*}
FHWA LTBP and Nondestructive Evaluation

Nondestructive Evaluation (NDE)
Web Manual, Version 1.0

Overview

What Is Nondestructive Evaluation (NDE)?

NDE is a means of analyzing and assessing the condition of various structural components of in-service highway infrastructure assets—pavement, bridges, and tunnels—without impairing their future usefulness.

Mission

The FHWA Advanced Sensing Technology (FAST) NDE Laboratory is a world-class national laboratory and is the centerpiece of FHWA's research and testing efforts related to the application of nondestructive testing technologies for condition assessment of highway infrastructure. The mission of the FHWA FAST NDE Laboratory is:

...to conduct state-of-the-art research, development, and implementation of nondestructive testing systems and technologies to improve the Nation's highway infrastructure assets.

Objectives and Goals
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 – Making Girders Composite
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
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QUESTIONS?
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