I-64 DUNLAP CREEK BRIDGE REHABILITATION – JOINTLESS BRIDGES, DECK OVERLAYS, AND CONCRETE MATERIALS

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Original 1963 Plan
• Two Bridges built in 1966
• Problems:
  • Leaking joints: damage to bridge seat, bearings, and substructure
  • Deck corrosion
• Rehabilitation
  • Bearings, seats
  • Substructure shotcrete
  • Hydromolition
  • Deck Extension and Micro Virginia Abutment
  • Fiber Reinforced Concrete in Closure Pours (Link Slabs)
  • Overlays
  • Research Council Implementation Fund
  • General rehabilitation
• Surveys
2014 Plan & Elevation View

**DECK CLOSURE/OVERLAY MATERIAL**

<table>
<thead>
<tr>
<th>Location</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Latex Modified Concrete</td>
</tr>
<tr>
<td>2</td>
<td>ECC: 2% PVA Fibers (0.4&quot;)</td>
</tr>
<tr>
<td>3</td>
<td>HyFRC: Synthetic Fibers 1.2% PP (2&quot;)</td>
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<tr>
<td>4</td>
<td>HyFRC: 0.6% Steel Fibers (2.4&quot;)</td>
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<tr>
<td>5</td>
<td>Silica Fume Concrete</td>
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<tr>
<td>6</td>
<td>Latex Modified Concrete</td>
</tr>
<tr>
<td>7</td>
<td>Low Cracking Shrinkage Reducing Admixture</td>
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<tr>
<td>8</td>
<td>Low Cracking Lightweight Coarse Aggregate</td>
</tr>
<tr>
<td>9</td>
<td>Low Cracking Partial Lightweight Fine Aggregate</td>
</tr>
</tbody>
</table>
Bearing Retrofit

Tall Rocker Bearings Removed

Jacking

Pedestal Reconstruction

New Elastomeric Bearing Pads
Micro Virginia Abutment

2½" is the constructed joint width measured normal to the joint at 60°F. For temperatures other than 60°F, corrections shall be made according to Section 494.05(c) of the Specifications.

Remove existing joint sanded and place EP-3 along the face of the approach slope and along the construction joint between the face and abutment seat.

Remove existing backwall 6" below this line and recoat to this line.
Deck Extension & Drainage Trough
Joint Elimination: Closure Pour (Link Slab)

- Eliminate joints
- Place closure pour
Closure Pours Can Crack

Numerous Shrinkage Cracks in the span continuity closure pour
## Project Goals

<table>
<thead>
<tr>
<th></th>
<th>Closure Pours</th>
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<th>Overlays</th>
<th></th>
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<tbody>
<tr>
<td><strong>Closure Pours</strong></td>
<td>3,000 psi in 24 hours</td>
<td>Crack control: No or very tight cracks (&lt;0.1 mm)</td>
<td>3,000 psi in 72 hours</td>
<td>SFC with LW aggregates and SRA</td>
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<tr>
<td><strong>Overlays</strong></td>
<td></td>
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<tr>
<td><strong>Control material:</strong></td>
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<tr>
<td><strong>Latex modified concrete (LMC)</strong></td>
<td>3,000 psi in 2.5 hours</td>
<td></td>
<td>3,000 psi in 72 hours</td>
<td>SFC with LW aggregates and SRA</td>
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<tr>
<td><strong>with rapid set cement</strong></td>
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Latex modified concrete (LMC) with rapid set cement has been used in VA since 1997.
Closure Pours and Overlays

[Diagram showing various materials and techniques for closure pours and overlays, including SFC, LMC, ECC with PVA, FRC with Polypropylene Fibers, and FRC with Steel Fibers.]
Preparation for closure pour

Dimensions:
- 16 feet long
- 4 feet wide
- 8-10 inches deep
- 2-3 yd$^3$
Closure Pour Materials

**LMC:** latex modified concrete with rapid set cement (control, no fibers)

**ECC:** engineered cementitious composite (“bendable concrete”) with PVA (polyvinyl alcohol) fibers (44 lb/yd$^3$)

**PP:** Polypropylene fibers (15 and 18 lb/yd$^3$)

**Steel fibers:** (66 and 80 lb/yd$^3$)
Fibers

Steel with hooked ends

Polyvinyl alcohol

Polypropylene
Flexure Test – ECC (Bendable Concrete) with PVA fibers
Flexure Test - Deflection Hardening ECC

Load [lbf] vs. Deflection [in]

- Load values range from 0 to 6,000 lbf.
- Deflection values range from 0 to 0.10 inches.

The graph shows a curve with an initial peak, followed by a decline, indicating the deflection behavior under load for ECC materials in a flexure test.
ECC

Deflection

Tight cracks
(<0.1 mm)
Previous application of ECC by VDOT: Shear Keys - Winchester Bridge (Route 645)

Non-shrink grout

UHPC

ECC with PVA fibers

After 3 months, only ECC did not leak
FRC in RMC Trucks

Fibers added manually, some with bags, some without.
“Wet” burlap covered with plastic for a day

Curing compound applied and opened to traffic
1-day 3,000 psi: monitored temperature and added accelerators
FRC

ECC – 44 lb/yd³

Steel - 80 lb/yd³

Polypropylene – 18 lb/yd³
Overlay Materials

LMC with Rapid Set (control)

Silica Fume Concrete (control)

Silica Fume with shrinkage reducing admixture

Silica fume with lightweight aggregates
  - Lightweight coarse aggregate (<120 lb/ft$^3$)
  - Internal curing with lightweight fine aggregate
Hydrodemolition to Remove Deteriorated Concrete
Mobile Mixer for LMC with Rapid Set
RMC Truck for Silica Fume Mixtures
Curing
Prompt application of wet burlap
Survey Results Soon After Placement
Closure Pours
FRC: No cracks or very tight cracks (< 0.1 mm)
LMC: > 0.2 mm cracks

ECC with PVA fibers

Other fibers had similar tight cracks

LMC with Rapid Set
No fibers
Later Survey 10/26/15

WB bridge: over 1 year old (ECC)

EB bridge: 3 - 4 months old (FRC with polypropylene and steel fibers)
Polypropylene and steel fibers FRC: no cracks or a crack < 0.1 mm wide

ECC: cracks < 0.1 mm wide with few as wide as 0.2 mm

LMC with rapid set: cracks up to 0.4 mm and few as wide as 0.5 mm
Tight crack < 0.1 mm
Wide crack > 0.2 mm

Latex modified concrete
Even the FRC that did not deflection harden exhibits tight cracks. Only a certain level of residual strength may be needed due to the presence of primary reinforcement in the closure pours.
Gaps Between the Closure Pour and Overlay

- FRC mixtures have high paste contents
- High shrinkage → gaps
- ECC highest shrinkage
Gaps Between Closure Pour and Overlay were filled with Epoxy

Longitudinal joint also filled with epoxy.
Overlays

SFC: performing well (no or very tight cracks)

LMC in left WB lane: cracks evident (had a truck fire on that lane)

LMC in right WB lane and EB bridge: less cracking observed
Rapid set with latex with extensive cracking (truck fire and high evaporation rate)
Conclusions

- Closure pours with FRC is performing well with tight cracks
- SF overlays with SRA or lightweight aggregates are performing well with no or tight cracks.
I-64 Bridge Rehabilitation Project over Dunlap Creek
Completed Project (WBL: 2014; EBL: 2015)
Thank you

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