Overlays are usually placed on bridge decks to reduce the infiltration of water and chloride ions and to improve the skid resistance, ride quality, and surface appearance.

HCC Deck Overlays

The objective of this presentation is to describe the key decisions with respect to hydraulic cement concrete (HCC) deck overlays that have provided long lasting chloride resistant overlays.
Key Overlay Decisions

1. Select a Good Contractor
2. Use Concrete that Provides the Required Properties
3. Achieve High Bond Strength (Key to Long Service Life)
4. Achieve Good Surface Properties
5. Achieve Good Protection Properties

1. Select a Good Contractor
- Overlays are difficult to construct.
- An experienced overlay contractor is less likely to have problems with the construction.
- Obtaining and maintaining the high bond strengths for long lasting overlays requires that appropriate construction decisions be made with respect to the selection and use of concrete removal and surface preparation equipment and procedures, mixture proportions, and placement and curing procedures.

2. Use Concrete that Provides the Required Properties
- Latex-modified concrete (LMC)
- Low water to cement ratio mixtures
- Silica fume (SF)
- Fly ash and SF
- Slag and SF
- LMC- very early (LMC-VE)
Typical Mixture Proportions

<table>
<thead>
<tr>
<th>Mixture</th>
<th>LMC</th>
<th>SF</th>
<th>Fly Ash</th>
<th>Slag</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/II Cement, lb/yd³</td>
<td>658</td>
<td>658</td>
<td>526</td>
<td>395</td>
</tr>
<tr>
<td>Silica Fume, lb/yd³</td>
<td>-</td>
<td>46</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Fly Ash, lb/yd³</td>
<td>-</td>
<td>-</td>
<td>99</td>
<td>-</td>
</tr>
<tr>
<td>Slag, lb/yd³</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>230</td>
</tr>
<tr>
<td>Fine Agg., lb/yd³</td>
<td>1552</td>
<td>1269</td>
<td>1351</td>
<td>1369</td>
</tr>
<tr>
<td>Coarse Agg., lb/yd³</td>
<td>1187</td>
<td>1516</td>
<td>1510</td>
<td>1510</td>
</tr>
<tr>
<td>Water, lb/yd³</td>
<td>146</td>
<td>282</td>
<td>254</td>
<td>254</td>
</tr>
<tr>
<td>Air, percent</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Admixtures</td>
<td>Latex</td>
<td>HRWR</td>
<td>HRWR</td>
<td>HRWR</td>
</tr>
</tbody>
</table>

High-Early Strength Overlays

24 hour cure time
- 15% latex and type III cement (LMC-HE)
- 7% SF and type I/II cement

3 hour cure time
- 15% latex and calcium sulfoaluminate and dicalcium silicate cement (LMC-VE)

3. Achieve High Bond Strength

- Deck concrete must be in good condition
- Minimal damage from concrete removal
- Surface preparation provides a sound, clean, textured and damp surface
- Concrete is properly consolidated
- Concrete is properly cured
- Minimal construction joints
- Minimal full depth cracks
Deck concrete must be in good condition

- Concrete has adequate strength
- Concrete has few cracks
- Reinforcement is not corroding
- Concrete is properly air entrained
- Concrete is not deteriorating (ASR, etc.)

Overlays should not be used to cover concrete that should be removed.

Concrete Removal Options and Typical Removal Depths

- Grit blasting < 2mm
- Shot blasting < 6mm
- Diamond grinding < rebar depth
- Scarification (milling) < rebar depth
- Hydro demolition 1mm to full depth

Fine Milling Drum (impact heads ≤ 8 mm apart) causes less fractures
Diamond Grind

Hydro Demolition Equipment

Good Surface Preparation

**Prescription Specification:**
Clean surface by shot blasting and other approved cleaning practices to remove asphalt, oils, dirt, rubber, curing compounds, paint, carbonation, laitance, weak surface mortar, and other detrimental materials that may interfere with the bonding or curing of the overlay.
Good Surface Preparation

Performance Specifications:
• Specify the macro texture that provides good surface preparation (≥ 0.06 in*).
• Specify the surface tensile strength that results from good surface preparation (≥ 250 psi*).
• Specify the overlay bond strength that results from good surface preparation (≥ 250 psi*).
*Different values may be appropriate.

Techniques for Preparing Concrete Surfaces

• Grit blasting
• Shot blasting
• Hydro demolition/power washing
• Power washing
• Air blasting

Grit Blasting
Preparation depends on operator
Steel shot clean the surface, shot are recycled, cuttings and dust are contained.

Surface Preparation by Shot Blasting

Surface Preparation Quality Control

• Monitor the macro texture of the prepared deck surfaces.
• Monitor the tensile strength of the prepared deck surfaces.
• Monitor the overlay bond strength.

The macro texture, tensile strength or bond strength should equal or exceed the minimum values for good surface preparation.

Insuring the Macro texture of the Prepared Surface is Acceptable

• Conduct macrotexture depth measurements (ASTM E 965)
• Compare the surface to the International Concrete Repair Institute molded profile that best represents the required texture (ICRI Guideline No. 03732, 9 concrete surface profiles)
ASTM E965 Macro texture Depth To Insure Surface Preparation

ICRI Molded Standards To Insure Surface Preparation

Insuring the Tensile Strength of the Prepared Surface is Acceptable
Insuring the Overlay Bond Strength is Acceptable

Determining the Acceptable Macro texture

1. Prepare test surfaces.
2. Determine the macro texture of the prepared test surfaces.
3. Measure the tensile strengths of the prepared test surfaces, ACI 503R, or construct test patches on the prepared surfaces and measure the tensile bond strengths of the test patches, ASTM C 1583.
4. When the bond strength or surface tensile strength is $\geq 250$ psi the macro texture is typically acceptable.

Polyethylene protects prepared deck surface until mobile mixer discharges latex-modified concrete.
Broom overlay mortar over surface, screed consolidates and strikes-off overlay

Proper Consolidation Required for High Bond Strength

Curing: wet burlap is placed on overlay as soon as practical
1. Curing: polyethylene is placed on wet burlap as soon as practical.

4. Achieve Good Surface Properties
   - Drainage
   - Ride quality
   - Surface appearance
   - Skid resistance (saw cut grooves)

5. Achieve Good Protection Properties
   - Overlay Thickness of 1.25 to 2.0-in
   - Low permeability to Chloride Ion (AASHTO T 277)
   - Low Shrinkage (ASTM C 157)
   - Minimal cracks
   - Minimal joints
### Permeability, coulombs

<table>
<thead>
<tr>
<th>Age</th>
<th>LMC</th>
<th>SF</th>
<th>Fly ash</th>
<th>Slag</th>
<th>LMC-VE</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 day</td>
<td>1500 - 2560</td>
<td>950 - 2330</td>
<td>1000 - 1160</td>
<td>1040 - 1390</td>
<td>300 - 1400</td>
</tr>
<tr>
<td>1 year</td>
<td>200 - 2060</td>
<td>590 - 1280</td>
<td>290 - 300</td>
<td>570 - 820</td>
<td>0 - 10</td>
</tr>
<tr>
<td>3 year</td>
<td>300 - 710</td>
<td>520 - 1460</td>
<td>300 - 360</td>
<td>500 - 590</td>
<td>-</td>
</tr>
<tr>
<td>5 year</td>
<td>450 - 500</td>
<td>780 - 910</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9 year</td>
<td>100 - 400</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0 - 60</td>
</tr>
</tbody>
</table>

Low: 1000 – 2000; very low: 100-1000; neg. < 100

### Shrinkage Cracks in Overlay

- Plastic shrinkage
- Autogenous shrinkage
- Drying shrinkage
- Thermal contraction
- Cracks in deck
- Live loads
Factors Contributing to Plastic Shrinkage Cracking

- Evaporation rate greater than 0.1 lb/ft²/hr
- Low relative humidity
- High concrete temperature
- High wind
- Delay in application of wet burlap
- Application of dry burlap
- Delay in application of plastic cover

Low Drying Shrinkage

Summary: Key Overlay Decisions

- Select a Good Contractor
- Use Concrete that Provides the Required Properties
- Achieve High Bond Strength (Key to Long Service Life)
- Achieve Good Surface Properties
- Achieve Good Protection Properties
Key Decisions for Concrete Deck Overlays

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Associate Director

Thank You
Questions?