Concrete Pavements for City Streets
Virginia Concrete Conference
March 7, 2008
Scott Haislip
Director of Streets & Roads

S&R Pavement Markets
- New/Reconstruction of Concrete Pavements
- Concrete Pavement Restoration - Utility Cuts
- Concrete Overlays
  - Bonded (UTW)
  - Unbonded (Whitetopping)
- Concrete Inlays
  - Intersections
  - Roundabouts
  - Bus Pads
  - Alleys

Remaining Service Life Model

New Design Tools for SLR
- StreetPave Software
  - Concrete Thickness
  - Asphalt Institute Design Thickness
  - Life Cycle Cost Analysis
- Information Sheet IS184
- Equivalent Pavement Design Charts

Equivalent Pavement Design

StreetPave Software
- Concrete pavement thickness design based on revised criteria
- Asphalt equivalent section based on converted total carrying capacity
- Life-Cycle cost analysis based on initial costs of equivalent pavements and predicted maintenance
Concrete Pavement Types
- Jointed Plain
- Undoweled
- Doweled
- Jointed Reinforced
- Continuously Reinforced
- Prestressed

Municipal Pavement Design
- Street classification and traffic
- Geometric design
- Subgrades and subbases
- Concrete quality
- Thickness design
- Jointing
- Construction specifications

Street Class | Description | Two-way Average Daily Traffic (ADT) | Two-way Average Daily Truck Traffic (ADT) | Typical Range of Slab Thickness
--- | --- | --- | --- | ---
Light Residential | Sheet roads in subdivisions and similar residential areas – often cut through. | Less than 200 | 2-4 | 4.0 - 10 ft (1.2-3.0 m)
Residential | sheet roads in subdivisions and similar residential areas that occasionally carry a heavy vehicle (truck or bus). | 200-1,000 | 10-50 | 5.0 - 10 ft (1.5-3.0 m)
Collector | Stems that collect traffic from several residential subdivisions, and that may serve buses and trucks. | 1,000-5,000 | 50-500 | 5.5 - 10 ft (1.5-3.0 m)
Business | Stems that provide access to shopping and other control business districts. | 5,000-17,000 | 500-700 | 6.0 - 10 ft (1.8-3.0 m)
Industrial | Stems that provide access to industrial areas or parks, and typically carry heavy trucks that the business class. | 2,000-4,000 | 300-500 | 7.0 - 10 ft (2.1-3.0 m)
Arterial | Stems that serve traffic from major expressways and carry traffic through metropolitan areas. Truck and bus lanes are primarily on their roads. | 4,000-15,000 | 4,000-10,000 | 6.0 - 10 ft (1.8-3.0 m)

Geometric Design
- Increase Edge Support
  - Integral Curb
  - Tied Curb & Gutter
  - Widened Lanes (2 feet no parking)
  - Parking Lanes
  - Rural Areas – Tied Concrete
  - Shoulders
- Street Widths
  - Minimum width of 25 ft.
  - Maximum Cross Slope of 2 percent ($\frac{1}{2}$ per ft.)
  - Traffic Lanes 10-12 feet
  - Parking Lanes 7-8 feet

Edge Support
- Concrete Parking
- Curb & Gutter
- Bicycle Lane

Basic Two-Lane Section
- 25' to 28' wide
- 28' to 42' wide
Concrete Pavement Restoration

- CPR Focused:
  - Full Depth Pavement Patching
  - Partial Depth Pavement Patching
  - Surface Grinding

- Utility Cuts

Utility Cuts

Full-Depth Utility Cut Patches

- Purpose
  - Restore structure
  - Restore ride

- Used for
  - Utility repair, replacement
  - Joint/crack deterioration
  - Broken panels

Planning Utility Cut Repairs

- If patch near joint (within 3-4 ft), extend to joint
- For small patches in interior of slab, simply tie into surrounding pavement with tiebars
- For long, trench patches, re-form joints in same locations as before
- Avoid odd-shaped patches
- Max. aspect ratio (length/width) = 1.5 to 2.0

Joint Types

- Replace existing joints with same
- Tie (i.e. deformed bars) to existing slab for interior patches, longitudinal joints, and transverse joints that are not full lane width
- Dowel (i.e. smooth bars) at all existing transverse joints, and new transverse joints that are full lane width
Planning Utility Cut Repairs

Steps in Utility Cut Repairs

- Isolate area to be removed with full-depth saw cuts
- Remove old concrete
- Place utility, compact backfill (or use CLSM), drain rainwater (if necessary)
- Provide load transfer at joint faces
- Place & finish new concrete
- Cure & insulate concrete
- Saw & seal perimeters

Defining Repair Limits

- If edge of patch within 3-4 feet of any joint, extend to joint (after utility work completed)
- Combine patches if close together

Combine Patches!

Sawing Boundaries Full-Depth

Perform Utility Work
Trench Compaction

Flowable Fill
- Controlled Low-Strength Material (CLSM)
- ½ to 1 sack of cement per cu.yd.
- No compaction needed
- Retains ability to be excavated
- Offers better support than granular fill
- For utilities and for pavement

Load Transfer

Drilling Dowel Holes

Dowel Sizes

<table>
<thead>
<tr>
<th>Pavement Thickness, in.</th>
<th>Dowel Diameter, in.</th>
<th>Drilled Hole Diameter, in. *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cement-Based Grout</td>
<td>Epoxy-Based Grout</td>
</tr>
<tr>
<td>6</td>
<td>0.75</td>
<td>0.95</td>
</tr>
<tr>
<td>7</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>8</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>9</td>
<td>1.25</td>
<td>1.45</td>
</tr>
<tr>
<td>10</td>
<td>1.25</td>
<td>1.45</td>
</tr>
</tbody>
</table>

* Cement-based, Dowel diam. + 0.2"  Epoxy-based, Dowel diam. + 0.08"
Installing Dowels

1. Inject Grout to Back of Hole
2. Twist one turn while pushing in dowel
3. Place grout retention disk to hold in grout (optional)

Injecting Grout

What NOT To Do

Dry out the grade!!

What NOT To Do

Placement of Bond-Breaking Board
Concrete Placement

Finishing

Texturing

Curing
Keys to Success

- Full-depth perimeter sawcuts
- Proper trench compaction is key in utility cuts; flowable fill (controlled low-strength material) can help
- Establish proper load transfer to existing pavement
- Finish smooth & level with surrounding pavement; and with a similar texture

Summary

- A few key details for repairs will help improve their performance
- Maintenance crews can be easily trained to do concrete repair work
- Tools, equipment, and materials required are readily available
- Proper maintenance & repair will extend concrete’s inherent long-life even further

Concrete Overlays - General Types

- Bonded Overlays
  (1913 Warsaw St. Toledo, OH)
- Unbonded Overlays
  (1916 Grand River Ave. Wayne County, MI)
- Whitetopping (1918 S. 7th St. Terre Haute, IN)
- Ultra-Thin Whitetopping (1991 Landfill Access Road near Louisville, KY)

Concrete Overlay History

- A few key details for repairs will help improve their performance
- Maintenance crews can be easily trained to do concrete repair work
- Tools, equipment, and materials required are readily available
- Proper maintenance & repair will extend concrete’s inherent long-life even further

Whitetopping – State of the Practice

ACPA
Engineering Bulletin Published (1998)
Std. Whitetopping
  Design
  Construction
  Performance
Ultra-Thin Whitetopping
  Design
  Construction
  Performance
Guide Contents

- Introduction
- Overview of the two overlay classes
- Six overlay types described in detail
- Design of concrete overlays
- Standard design details
- Materials
- Key points

Available through www.pavement.com publication # TB021P

Classes of Concrete Overlays

Bonded (UTW)

Before

After

Unbonded (Whitetopping)

Before

After

Unbonded

Before

After
Bonded Composite

Before

After

Bonded Summary
- Bonded overlays are rapidly gaining in popularity, particularly in urban environments
- They have been used at intersections, bus pads, highway ramps, parking areas, subdivision streets
- Performance has generally been excellent
- Where problems occurred, improper placement reducing bond

Unbonded Summary
- Conventional whitetopping is probably over designed by not accounting for bond
- The new StreetPave Mechanistic Pavement Design software will produce a more optimized design than previous design methods
- Projects can be constructed and opened to traffic in a relatively short time (fast-track techniques)
- Performance has been excellent

Concrete Inlays
- Intersections
- Bus Stops
  (Chicago 1000 full and partial depth pads)
- Alleys
- Turn Lanes

Concrete Inlays (cont.)
- Turn Lanes
- Any Stopping Area

Main Street USA Award
- City of Muskegon, Michigan
- New Castle, Pennsylvania
Questions

Thank you

For additional information, please contact Scott Haislip at shaislip@pavement.com or visit the American Concrete Pavement Association website at www.pavement.com