Cement-Based Pavement Solutions

Presented by Shadrack Mboya, P.E.
CEMEX IS ONE OF THE LEADING BUILDING MATERIALS SUPPLIERS IN THE INDUSTRY

Alabama is the fifth largest producer of cement in USA

Sources:
INITIAL PRICE GAP BETWEEN ASPHALT & CONCRETE HAS NARROWED

Oil price has recently declined, but long-term, expected trend is to continue upward

Asphalt Inflation has been significantly higher, and more volatile than Concrete

2. CAGR = Compound Annual Growth Rate
THE ADOPTION OF THESE ELEMENTS WILL INCREASE COMPETITION AND LOWER OVERALL COST OF PAVEMENT CONSTRUCTION

Elements that make Concrete Competitive

1. Adoption of Proper Pavement Design Procedure
   - Removes over-design and lowers initial costs

2. Accounting for Maintenance Costs
   - Most owners & engineers do not account for maintenance costs. Maintenance cost will help determine the best pavement alternative.

3. Adoption of Alternate Design / Alternate Bid (ADAB)
   - 90% of projects are designed with Asphalt only
   - Concrete may not even have the chance to bid....
   - ADAB has both asphalt and concrete designs and both are bid

While there are benefits of each element, when COMBINED there are synergistic effects that have proven to make concrete pavements competitive
TYPICAL MISPERCEPTION IS THAT ASPHALT PAVEMENTS ARE CHEAPER THAN CONCRETE PAVEMENTS

HISTORICALLY ASPHALT HAS BEEN LOWER ON INITIAL COST (TYP. 15 TO 35 % CHEAPER)
SINCE 2004, IMPROVED DESIGNS AND HIGH OIL PRICES HAS NARROWED INITIAL PRICE GAP (TYP. SIMILAR OR CHEAPER THAN ASPHALT)

Typical Life Comparison: 20 years 30+ years

New Concrete Design = 4% lower

With new designs and longer life, concrete can be cost competitive and much lower in Life Cycle Costs
(Concrete paving traditionally been over-design, having significant impact on initial costs)

(1) AC Price = $45/Ton
(2) Granular Base = $15/Ton
(3) Concrete = $62/CY
(4) Additional Curb and Gutter = $10/LF asphalt , Concrete Monolithic = $4/LF
Note: 5000 SY Parking Lot
**Comparing Costs for 20 Year Ownership Between Asphalt and Concrete Pavements…**

Very little concrete maintenance is expected.

**Clean and Striping**

- **Crack Seal**
  - Surface needs to be degreased and restriped (every 10 years)

**Crack Seal**

- Concrete surface maintains structural capacity
- Cracks can be sealed to avoid moisture penetration (every 20 years), cost $2/lf - $1,800/application

**Note:** 5000 SY Parking Lot

**Costs inflated at 4% annually**

<table>
<thead>
<tr>
<th>Maintenance Interval</th>
<th>Typical Schedule and Cost for Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning and striping</td>
<td>$9,430</td>
</tr>
<tr>
<td>Crack Seal</td>
<td>$3,710</td>
</tr>
<tr>
<td>Stripe &amp; Seal</td>
<td>$3,710</td>
</tr>
</tbody>
</table>

Parking Lot Age (years)

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1. Costs are calculated based on a 5000 SY Parking Lot with inflation at 4% annually.
ASPHALT MAINTENANCE IS REQUIRED OFTEN

**Seal Coat**
- Asphalt surface cracks, ravels, oxidizes
- Seal coat fills cracks and rejuvenates surface
- Apply every 3 to 5 years
- Recommended by Asphalt Institute
- Expected cost $1.50/SY - $7,500/application¹

**Pavement Striping**

**Maintenance Interval**

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Cost (in $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal coat and stripe</td>
<td>$9,130, $11,110, $31,520</td>
</tr>
<tr>
<td>Re-Surface &amp; Stripe</td>
<td>$16,440</td>
</tr>
</tbody>
</table>

**Typical Schedule and Cost for Maintenance**

Note: 5000 SY Parking Lot
Costs inflated at 4% annually

¹Current costs
THE 20 YEAR OWNERSHIP COSTS FOR CONCRETE PAVEMENT ARE $46.3K LESS THAN ASPHALT FOR A 5000 SY PARKING LOT

Nominal cost by pavement type for 5000 SY parking lot ($ K)

<table>
<thead>
<tr>
<th>Parking Lot Age (years)</th>
<th>Concrete</th>
<th>Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$126.0</td>
<td>$139.0</td>
</tr>
<tr>
<td>5</td>
<td>$9.1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>$3.7</td>
<td>$11.1</td>
</tr>
<tr>
<td>15</td>
<td>$31.5</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>$9.4</td>
<td>$16.4</td>
</tr>
</tbody>
</table>

Inflation rate – 4.0%, Discount Rate = 4.0%
Seal coat and stripe application every 5 years, cost $1.50/SY
Concrete cleaning and re-striping every 10 years, cost $0.50/SY
Concrete crack sealing every 20 years, $2/LF

Concrete is 26% Lower

Present Value ($ K)

- asphalt: $179
- concrete: $132.7
## Using Other Industry Recognized Practices Can Make Concrete More Competitive

<table>
<thead>
<tr>
<th>Element</th>
<th>Objective</th>
<th>Recommendation</th>
<th>Cost Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Thickness(1)</td>
<td>Design thickness to match expected traffic</td>
<td>Do not use artificial minimums</td>
<td>15-25%/inch</td>
</tr>
<tr>
<td></td>
<td>ACI 330 Guide</td>
<td>ACI 330 Guide</td>
<td></td>
</tr>
<tr>
<td>Granular Base</td>
<td>Used to prevent pumping</td>
<td>Use in high truck traffic areas (&gt;200/day)</td>
<td>15-25%</td>
</tr>
<tr>
<td></td>
<td>Used as construction platform</td>
<td>Appropriate compaction of subgrade</td>
<td></td>
</tr>
<tr>
<td>Wire Welded Mesh</td>
<td>To hold cracks that may occur together</td>
<td>Use proper joint spacing</td>
<td>7-12%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eliminate welded wire mesh</td>
<td></td>
</tr>
<tr>
<td>Fibers</td>
<td>To add impact resistance</td>
<td>Most effective for thickness &lt; 5”</td>
<td>3-8%</td>
</tr>
</tbody>
</table>

1: Based upon 5,000 sq. yds.; Concrete = $85/CY  
Granular Base = $25/ton, Concrete w/ Fibers = plus $3/CY
HIGHER ALBEDO CONCRETE SURFACES REFLECT MORE LIGHT AND EXHIBIT COOLER SURFACE TEMPERATURE

Heat Island
- High albedo concrete reflects significantly more sunlight than asphalt
- Surface temperature is ~12°C lower than asphalt
- Lower temperature reduces smog and decreases air conditioning requirement
  - Decreases monthly utility bills
  - Decreases levels of pollution (CO2, NOx, SOx, PM, VOC, smog)

Lighting Needs
- Higher albedo than asphalt in both new & weathered conditions
  - The average luminance of concrete is 1.77 times higher than asphalt
- Asphalt requires 24-40% more poles for same lumens as concrete
  - 24-57% more electrical energy
- Lighting cost for concrete is on average 37% lower than asphalt

Higher reflectivity lowers lighting cost and increases safety
Light color reduces cooling loads for nearby structures

9:00 pm February Springfield, IL, 5 minutes of each other. Same camera settings, same-size lots, same light poles
SUSTAINED COMPETITION BETWEEN THE PAVING MATERIALS INDUSTRIES BRINGS VALUE TO THE TAX PAYERS

- No state spends more than 40% of paving dollar on concrete – on average
  - MAJORITY of states spend less than 15% of paving dollars on concrete pavement

- As competition increases between industries
  - Prices decrease
  - Innovation increases
  - Quality improves

- Allows agencies to build more pavements for same investment!

Source: ACPA - Two Pavement System: Competition Between Industries can Lower Unit Costs and Allow Highway Agencies to do More With Their Budgets
### COMPETITIVE PAVING PROGRAM

Same data viewed through a break-even analysis…

<table>
<thead>
<tr>
<th>Budget</th>
<th>Concrete Portion of Budget</th>
<th>Expenditure on Asphalt ($)</th>
<th>Asphalt Unit Price ($)</th>
<th>Tons of Asphalt</th>
<th>Expenditure on Concrete ($)</th>
<th>Concrete Unit Price ($)</th>
<th>Square Yards of Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>$200 M</td>
<td>0%</td>
<td>$200 M</td>
<td>$83.88</td>
<td>2,384,232</td>
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<tr>
<td>$200 M</td>
<td>5%</td>
<td>$190 M</td>
<td>$81.24</td>
<td>2,338,829</td>
<td>$10 M</td>
<td>$66.94</td>
<td>149,380</td>
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<tr>
<td>$200 M</td>
<td>10%</td>
<td>$180 M</td>
<td>$78.59</td>
<td>2,290,382</td>
<td>$20 M</td>
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<td>$200 M</td>
<td>15%</td>
<td>$170 M</td>
<td>$75.94</td>
<td>2,238,558</td>
<td>$30 M</td>
<td>$49.81</td>
<td>602,348</td>
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<tr>
<td>$200 M</td>
<td>20%</td>
<td>$160 M</td>
<td>$73.29</td>
<td>2,182,989</td>
<td>$40 M</td>
<td>$45.32</td>
<td>882,666</td>
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<tr>
<td>$200 M</td>
<td>25%</td>
<td>$150 M</td>
<td>$70.65</td>
<td>2,123,255</td>
<td>$50 M</td>
<td>$41.84</td>
<td>1,195,137</td>
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<td>$200 M</td>
<td>30%</td>
<td>$140 M</td>
<td>$68.00</td>
<td>2,058,869</td>
<td>$60 M</td>
<td>$38.99</td>
<td>1,538,778</td>
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<tr>
<td>$200 M</td>
<td>35%</td>
<td>$130 M</td>
<td>$65.35</td>
<td>1,989,266</td>
<td>$70 M</td>
<td>$36.59</td>
<td>1,913,236</td>
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</table>
METHODS THAT INCREASE COMPETITION HAVE BEEN SHOWN TO LOWER PROJECT COSTS
29 states have used Alternate Design Alternate Bid at least once

<table>
<thead>
<tr>
<th>State</th>
<th>AD/AB Results</th>
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<tbody>
<tr>
<td><strong>Indiana</strong></td>
<td>• Used on 64 projects&lt;br&gt;• On 26 projects evaluated between 2009 and 2011, AD/AB saved the state $13M in initial costs and an estimated $93.4M in Life Cycle Costs</td>
</tr>
<tr>
<td><strong>Kentucky</strong></td>
<td>• Used on 44 projects, with a documented savings of $148M&lt;br&gt;• 32 of the 44 projects had both asphalt and concrete bidders, with two being awarded to concrete - highlighting the incredible savings potential of increased competition</td>
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<td><strong>Louisiana</strong></td>
<td>• Used AD/AB on 47 projects between 2001 and 2009&lt;br&gt;• Cost savings of $120M on these 47 projects</td>
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<td><strong>Missouri</strong></td>
<td>• Used on 124 projects through July 2009&lt;br&gt;• ADAB yielded a 10% decrease in unit costs for both asphalt and concrete.</td>
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<td><strong>Ohio</strong></td>
<td>• Used on more than 10 projects&lt;br&gt;• An industry study of five projects in let 2009 documented a savings of $58M</td>
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<tr>
<td><strong>West Virginia</strong></td>
<td>• WV has used AD/AB on 13 projects&lt;br&gt;• The state has documented a savings of $16.4M on their six most recent projects</td>
</tr>
</tbody>
</table>

Sources:
1. Alternate Bidding History and Requirements. Thomas L. Duncan, PE (FHWA) and David B. Holtz, PE (INDOT). March 2013
5. New ODOT Policy on Alternate Bids. Roger Faulkner, PE. Director of Engineering & Promotion, Ohio Concrete. December 2010
## CEMENT-BASED PAVEMENT SOLUTIONS

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<tr>
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<th>Roller Compacted Concrete</th>
<th>Concrete Overlays</th>
<th>Cement Treated Bases</th>
<th>Soil Stabilization</th>
<th>Pervious Concrete</th>
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CONCRETE AND ASPHALT PAVEMENTS ARE DIFFERENT BASED ON HOW THEY DELIVER LOADS TO THE SUBGRADE

Concrete Pavements are rigid

- Loads are distributed over a large area through slab action.
- Minor deflections.
- Low subgrade contact pressures.
- Subgrade uniformity is more important than strength.

Asphalt pavements are flexible

- Loads are more concentrated.
- Deflections are higher
- Subgrade, base and subbase strength are very important.
- Usually require more layers and greater thickness for optimally transmitting load to the subgrade

Concrete’s Rigidity spreads the load over a large area & keeps pressures on the subgrade low
WHY ARE JOINTS NECESSARY?

- The concrete will crack after placement
  - Joints tell the concrete where to crack
- Why does concrete crack after placement?
  - Concrete drying shrinkage
  - Changes in temperature and moisture
    - Ambient (contraction)
    - Gradient (curling)
  - Subbase restraint (friction or bond)
  - First applied loads

Proper jointing provides a series of saw cuts (joints) spaced to control crack formation.

Recommended Maximum Joint Spacing (2 x thickness in ft)

<table>
<thead>
<tr>
<th>Pavement thickness, in.</th>
<th>Spacing range, ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 4.5</td>
<td>6-10</td>
</tr>
<tr>
<td>5 to 5.5</td>
<td>7.5 -12.5</td>
</tr>
<tr>
<td>6 or greater</td>
<td>10-15</td>
</tr>
</tbody>
</table>

Erratic crack patterns due to no joints.
### TYPES OF JOINTS IN CONCRETE PAVEMENTS

<table>
<thead>
<tr>
<th>Details For Use</th>
<th>Typical Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contraction (Control) Joint</strong></td>
<td>![Contraction Joint Diagram]</td>
</tr>
<tr>
<td>➢ Use at short joint spacing</td>
<td>d/4 MINIMUM</td>
</tr>
<tr>
<td>➢ Made by saw cut, or tooled</td>
<td></td>
</tr>
<tr>
<td>➢ Early entry cuts = 1” deep</td>
<td></td>
</tr>
<tr>
<td>➢ Saw cut within 2 to 6 hours of paving</td>
<td></td>
</tr>
<tr>
<td><strong>Construction Joint</strong></td>
<td>![Construction Joint Diagram]</td>
</tr>
<tr>
<td>➢ Use at end of construction day</td>
<td></td>
</tr>
<tr>
<td>➢ Use thickened edge for heavy duty applications</td>
<td></td>
</tr>
<tr>
<td>➢ Keyways not recommended</td>
<td></td>
</tr>
<tr>
<td><strong>Isolation (Expansion) Joint</strong></td>
<td>![Isolation Joint Diagram]</td>
</tr>
<tr>
<td>➢ Isolate pavement features with differential movements</td>
<td>1/4&quot; - 1/2&quot; ISOLATION JOINT FILLER</td>
</tr>
<tr>
<td>➢ Do not use at regular spaced joints in paving lane</td>
<td></td>
</tr>
<tr>
<td>➢ Full thickness, vertical joint, sealed with compressible material</td>
<td></td>
</tr>
</tbody>
</table>

1) Jointing recommendations should be based on ACI 330
STEEL REINFORCEMENT IS NOT NECESSARY FOR CONCRETE PAVEMENTS

- Steel reinforcement has minor effect on a pavement’s load-carrying capacity or thickness
  - It does effect the joint design of the pavement
  - Joints are placed according to the system selected and identifies the “concrete pavement type”
- For all paving applications, industry does not recommend using mesh reinforcing steel
  - Not enough mesh to add strength
  - It is rarely placed at the correct depth
- Cost impact – 7 to 12%
- Save money with tighter joint spacing instead of spending money on reinforcing for similar performance
DO I NEED DOWELS?

Dowels are used to improve Load Transfer

A slab’s ability to share its load with neighboring slabs

1. Dowels

2. Aggregate Interlock
   - Shear between aggregate particles below the initial saw cut

3. Concrete shoulders, extended lane, & curb and gutter aid load transfer

Trucks Control Thickness and Deflections

- Include dowels if:
  - Slab thickness > 8.0 inches

- Exclude dowels if:
  - Slab thickness < 7.0 inches

Other issues:
- Speed of Traffic (Speeds >~30 mph more apt to need dowels)
- Channelized traffic (more apt to need dowels)
- Direction (single direction more apt to need dowels)
A SUBBASE IS PRIMARILY USED TO PREVENT PUMPING/EROSION OF SUBGRADE

- Purposes of the subbase are:
  - To minimize or eliminate the potential for pumping, subgrade expansion due to clay or frost
  - Provide construction platform
- Use a subbase if:
  - Category C, k – value less than 200
  - Multiple truck semi-trailer daily applications
  - Non-uniform soil conditions
  - Wet soil that might hamper construction
- Exclude subbase if:
  - Non-pumpable subgrade soil (< 45% passing #200 sieve & PI <6 )
  - It is not economical to use thick subbases to increase structural capacity
  - Cost impact – 15 to 25%

Pumping is the forceful displacement of soil and water from underneath a concrete slab

For parking lots, bases are not usually required, however if required use a **Granular Base** (or a Cement Stabilized Subgrade)

**Conditions for Pumping**

1. Subgrade soils that are erodible
2. Free water between slab and subgrade
3. Frequent heavy wheel loads
# CEMENT-BASED PAVEMENT SOLUTIONS

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ROLLER COMPACTED CONCRETE HAS LONG HISTORY OF GOOD PERFORMANCE ON HEAVY DUTY PAVEMENTS

Roller Compacted Concrete (RCC) Pavements
- No Slump
- Consistency of damp gravel
- Placed by asphalt pavers
- Compacted with vibratory rollers
- No forms
- No reinforcing steel
- No finishing
- Max lift thick – 8 to 10 in
- Low W/C ratio = limited shrinkage cracks
- High-production rate (typ. 1900 LF/day)
- Typical Traffic Opening within 24 hours
- Typically 5 to 15% cheaper than conventional concrete

Honda Automotive Facility – Lincoln, AL
1.5M Square Yards/ 5” and 7” RCC /4”CTB

Willow Lane – Hayesville, KS (2011)
5” RCC / 6” recycled base / clay

Birmingham Regional Intermodal Facility
60,000 CY of 9” and 16” RCC

RCC have been successfully used for intermodal Port / freight / manufacturing yards. It is also used on city streets and Residential subdivisions. Go to rcc.acpa.org for projects examples
RCC EXPLORER DATABASE SHOWS WHERE RCC HAS BEEN DONE
rcc.acpa.org
THE SURFACE APPEARANCE AND TEXTURE OF RCC IS SIMILAR TO ASPHALT PAVEMENT

- Similar appearance & texture as asphalt only light grey instead of black
- Surface texture depends on aggregate gradation and paste content
- Diamond ground RCC is similar to diamond ground concrete
- Trowelled RCC similar appearance as conventional concrete
# CEMENT-BASED PAVEMENT SOLUTIONS

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Concrete overlays have similar long-term durability and cost advantages of traditional concrete pavements. 

- Add strength and durability to an existing pavement
  - Can restore or add design life to existing pavement

- Competitive on Initial & Life Cycle Cost
  - Dollar for dollar, one of most effective long-term options
  - A wide range of thicknesses can be used
  - Can be designed to last from 10 to 40+ years

- Can be placed on both concrete and asphalt pavements.
  - Existing pavement does not have to be removed
  - Few pre-overlay repairs are necessary
  - Use normal concrete pavement construction practices

- Have good safety and sustainability characteristics
  - Reduced pavement removal / use existing structure
  - Uses fewer virgin materials
  - High skid resistance and non-rutting
  - High reflectivity = greater visibility, lower surface temperature
  - Stiff system = better fuel efficiency
  - Fewer construction emissions

Coolidge Road, Michigan
5 inch (125 mm) concrete overlay & widening, built September 1983
Picture circa 2001
First Rehabilitation done in 2015
after 32 years
MOST STATES HAVE SOME CONCRETE OVERLAY EXPERIENCE
ACPA Concrete Explorer database provides details on over 1200 projects

**States with Concrete Overlay Experience**

**Iowa**
- Over 500 different overlay projects
- First project in 1960
- Most projects on county road system

**Missouri**
- Using Alternate Bid/Alternate Designs (concrete vs Asphalt) for high volume highways
- Majority of overlay projects have gone concrete

**Colorado**
- Has pioneered the use of thin concrete overlays

**Michigan**
- Over 18 projects of 6 to 8 in. (150 to 200 mm) concrete overlays on interstate applications

**Illinois**
- Has constructed 81 overlays since 1974.
- 65 been over asphalt or composite pavement

---

1. Iowa Concrete Pavement Association
2. National Concrete Pavement Technology Center (CPTech Center)

http://overlays.acpa.org/webapps/overlayexplorer/index.html
CONCRETE OVERLAYS FALL INTO TWO FAMILIES
Overlay family is dependent on how the interface between layers is treated

Concrete Overlays

Bonded Family (Typical Thick = 3 to 6 in)
- Bonded Concrete Overlay of Concrete Pavements
- Bonded Concrete Overlay of Asphalt Pavements
- Bonded Concrete Overlay of Composite Pavements

Unbonded Family (Typical Thick = 5 to 11 in)
- Unbonded Concrete Overlay of Concrete Pavements
- Unbonded Concrete Overlay of Asphalt Pavements
- Unbonded Concrete Overlay of Composite Pavements

Bond is integral to design (Existing pavement is in relatively good shape)

Old pavement is base (Existing pavement is in poor condition)
THE CHOICE BETWEEN BONDED OR UNBONDED OVERLAY IS PRIMARILY BASED ON THE EXISTING PAVEMENT CONDITIONS

Other Issues that dictate viability of an overlay
- Roadway type (Interstate vs Arterial vs Collectors)
- Urban vs Rural
- Site specific considerations
  - shoulder, bridges, and other vertical clearance issues
- Traffic control options & Time to open
# TYPICAL THICKNESS FOR THE DIFFERENT OVERLAY TYPES

Exact thickness depends on traffic, subgrade, and climatic region

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<tr>
<th>Typical Concrete Thickness for Urban Applications</th>
<th>Typical Concrete Thickness for Rural Applications</th>
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<tbody>
<tr>
<td><strong>Interstate &amp; Expressways</strong></td>
<td><strong>Principal &amp; Minor Arterials</strong></td>
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<td>2-4 in (50 to 100 mm)</td>
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<td>3-6 in (75 to 150 mm)</td>
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<td>6-11 in (150 to 280 mm)</td>
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Interstate & Expressways – 4 lane or more divided highways with limited access
Arterials - moderate or high-capacity roadways which typically carry vehicles for longer trips (many rural state highways are included in this category)
Collectors – collect & disperse traffic between arterials and local roads or from sections of neighborhoods (rural farm to market roads are included in this category)
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WHAT IS PERVIOUS CONCRETE?

An EPA “Best Management Practice for Storm Water Control”
- Has 15-35% air voids to allow water to percolate
- Has no slump mix
- Typically uses single size aggregate
- Has rough surface texture
- Has unit weight less than conventional concrete
- Provide savings to site owners through storm water management, increased land area use, decrease construction costs, minimal maintenance

Prime Retail Outlets, Williamsburg, VA

The owner closed the existing detention pond, paved 7.6 acres with pervious concrete, paved 3.5 acres conventional / non-pervious surfaces, and made 40% additional rental space available.

1. National Ready Mixed Concrete Association (NRMCA) Presentation
WHERE HAS PERVIOUS CONCRETE BEEN USED?

Streets and Roads

Parking Lots

Sidewalks

Others
TYPICAL PERVIOUS CONCRETE PROFILE

Adopted from United States Environmental Protection Agency (EPA) 2010

1. Technical Brief FHWA-HIF-13-006, Figure 1
1. Traffic:
- Pedestrian/Sidewalk (typically 4 inches min.)
- Standard Duty Traffic (typically 6 inches min.)
- Heavy Duty Pavement (typically 8 inches min.)
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SOIL STABILIZATION IS A COST EFFECTIVE TREATMENT OF POOR SOILS THAT ARE INADEQUATE FOR CONSTRUCTION

1. What is it?
- Mixing calcium based additives into the soil
  - Low PI: Cement, fly ash, asphalt
  - Mid PI: Lime, cement, fly ash, other products
  - High PI: Lime, Lime-cement, cement, fly ash

2. What does it do?
- Increases workability, strength, compaction of soils
- Reduces moisture susceptibility, mitigating subgrade expansion due to clay or frost
- Provide construction platform
- Provide uniform, stable support
- Eliminating the potential for pumping of the subgrade

3. Cost Comparison
- Typically cost less than half of aggregate base materials.

When soil stabilization is used under light to medium duty pavements, soil erodibility is reduced eliminating the need for granular bases

(1) PI – Plasticity index – measure of soil plasticity. Low PI = Sand, High PI = Clay
(2) Majority of soil stabilization is done on mid to high PI soils
FULL-DEPTH RECLAMATION (FDR) WITH CEMENT

Full-Depth Reclamation
- Deteriorated asphalt pavement and underlying materials are pulverized
- Typical pulverized depth is between 6 and 10 inches.
- Pulverized materials are mixed with cement (dry) and water to form a cement-treated stabilized base. Cement slurry form is also an option.
- The mix is then compacted within 2 hours and allowed to cure
- Typically cost $160,000 to $180,000 per lane mile.
Thank You

& Any Questions?

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