THE READY MIX USA COMPANIES
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A CEMEX COMPANY

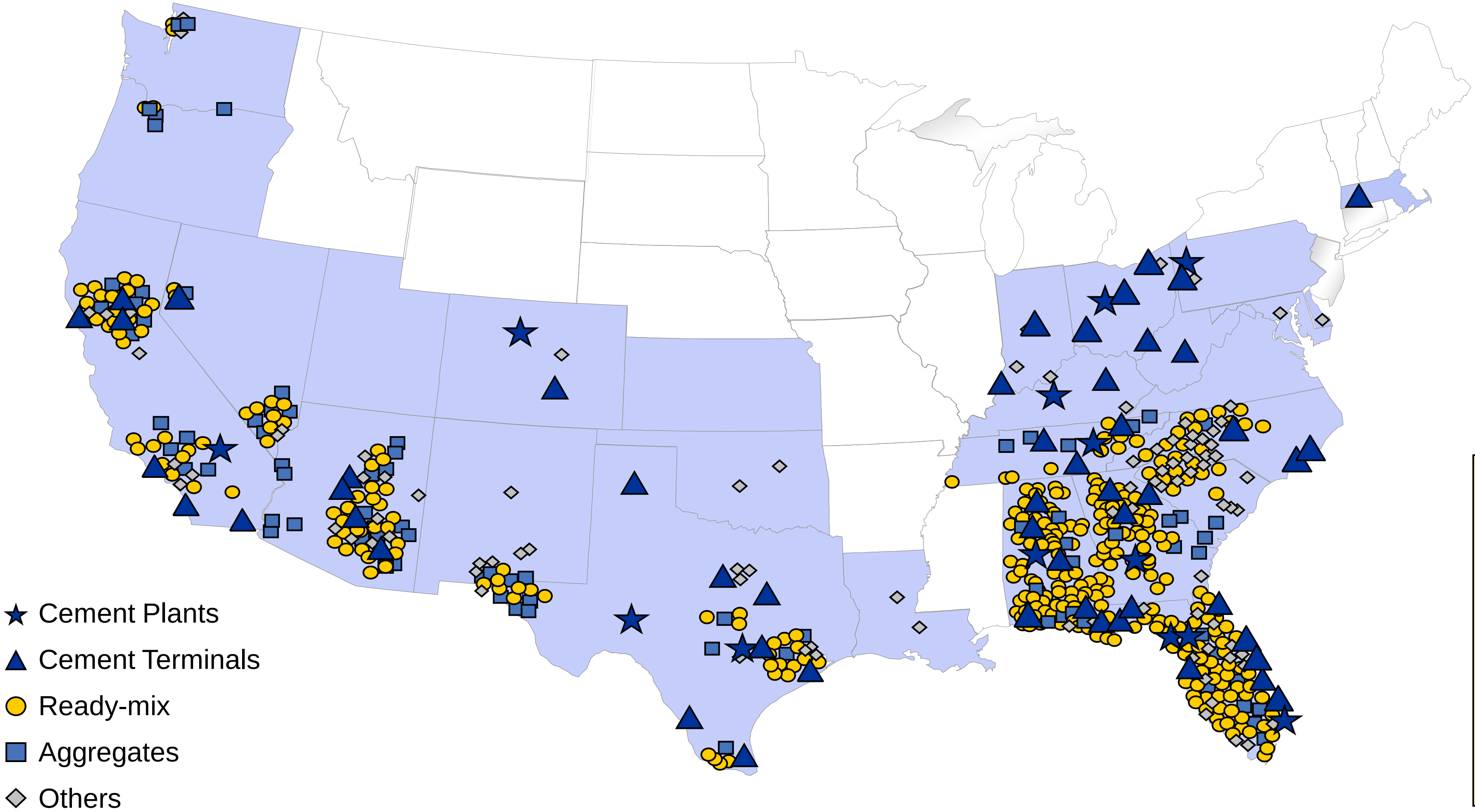
PROVIDING SOLUTIONS THROUGH PAVEMENT DESIGN

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[1]



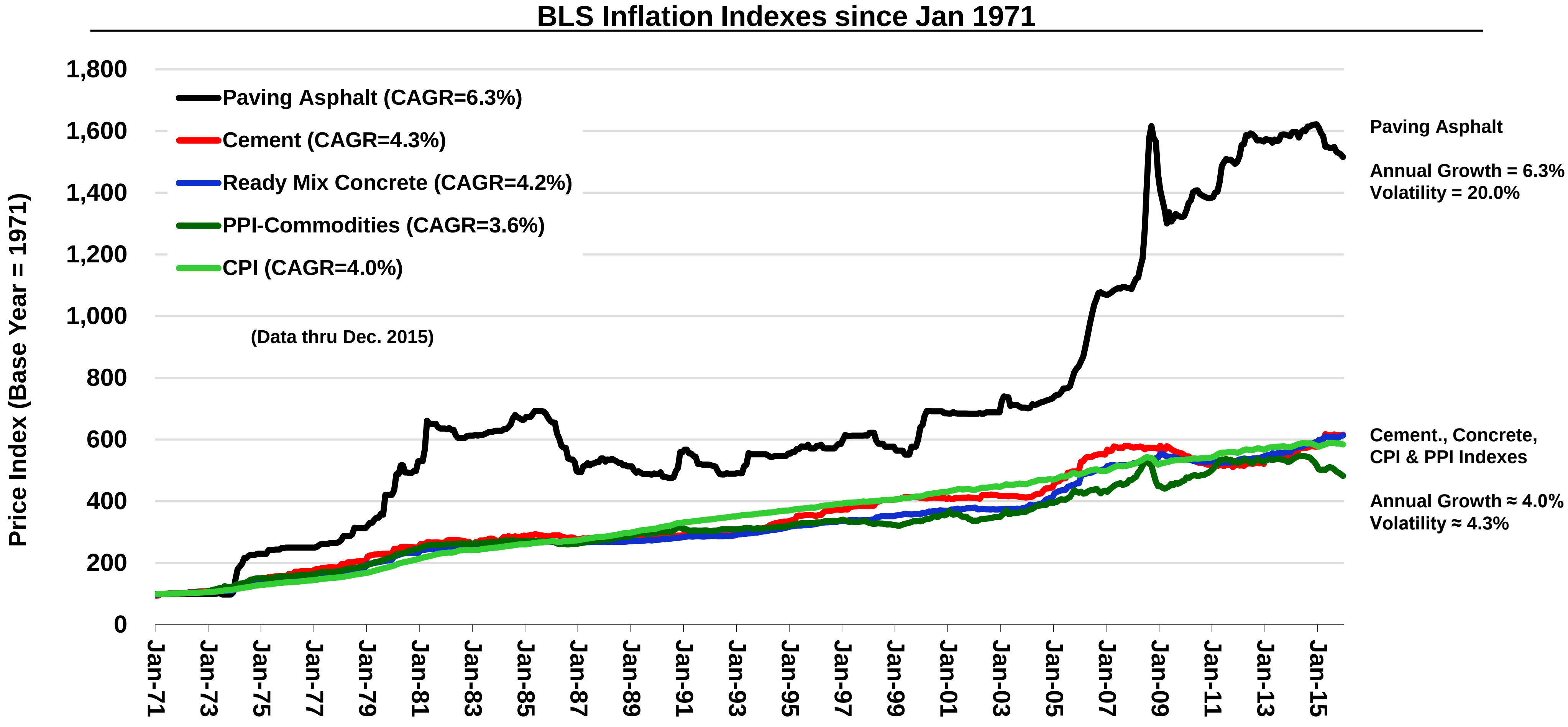
Plants
Cement: 11
Ready-mix: 292
Aggregates: 61
Block: 21
Pipe: 29
Gypsum: 31
Fly Ash: 33
Precast: 5
Others: 28

Widespread raw materials reach and portable batch plants allow us to supply most locations

Sources:
1. Cement Industry in the United Sates, Wikipedia, 2013

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

1. U.S. Department of Labor, Bureau of Labor Statistics, http://www.bls.gov/ppi/home.htm
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.**

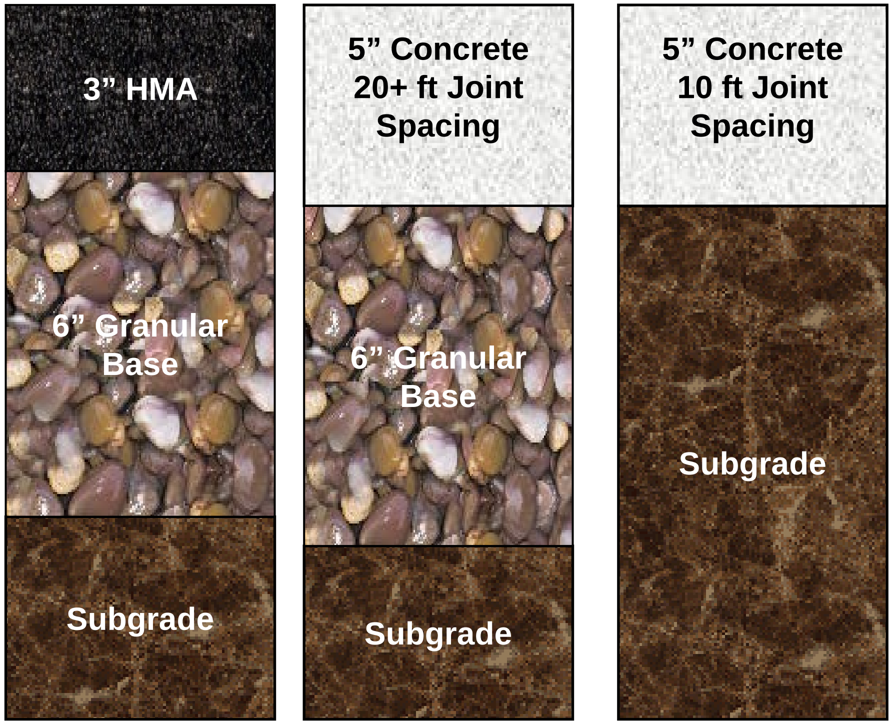
3. **Adoption of Alternate Design / Alternate Bid (ADAB)**
   - **90% of projects are designed with Asphalt only**
   - **Concrete may not even have the chance to bid….**
   - **ADAB has both asphalt and concrete designs and both are bid**

While there are benefits of each element, when COMBINED there are synergistic effects that have proven to make concrete pavements competitive

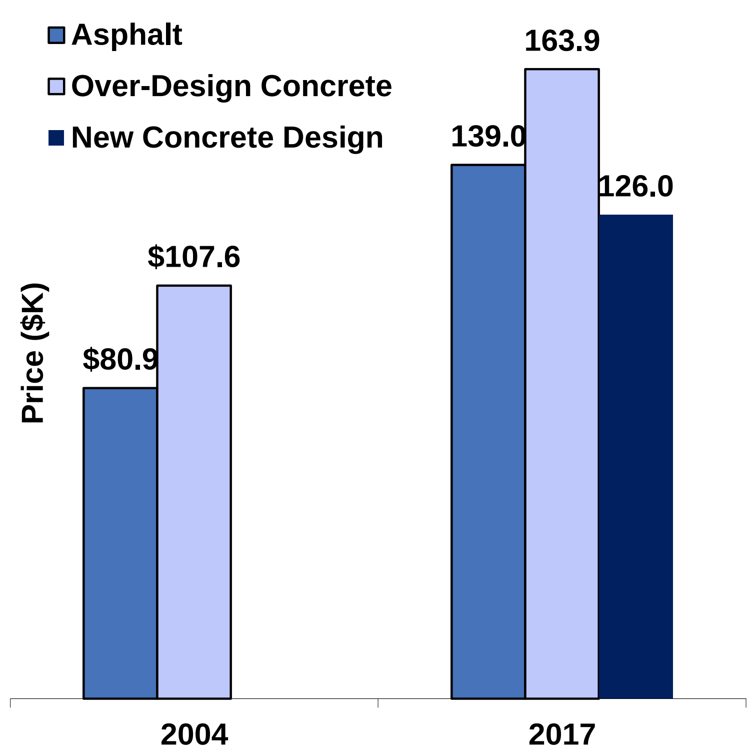
TYPICAL MISPERCEPTION IS THAT ASPHALT PAVEMENTS ARE CHEAPER THAN CONCRETE PAVEMENTS

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)

Typ. Asphalt Design	Over-Design Concrete (Typ. 15 - 35% Higher on initial cost)	New Concrete Design (Using ACI 330R-08)



New Concrete Design = 4% lower



Initial cost comparison for year 2004 and 2017

Typical Life Comparison:	20 years	30+ years	30+ years

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

Maintenance Interval

Cleaning and striping

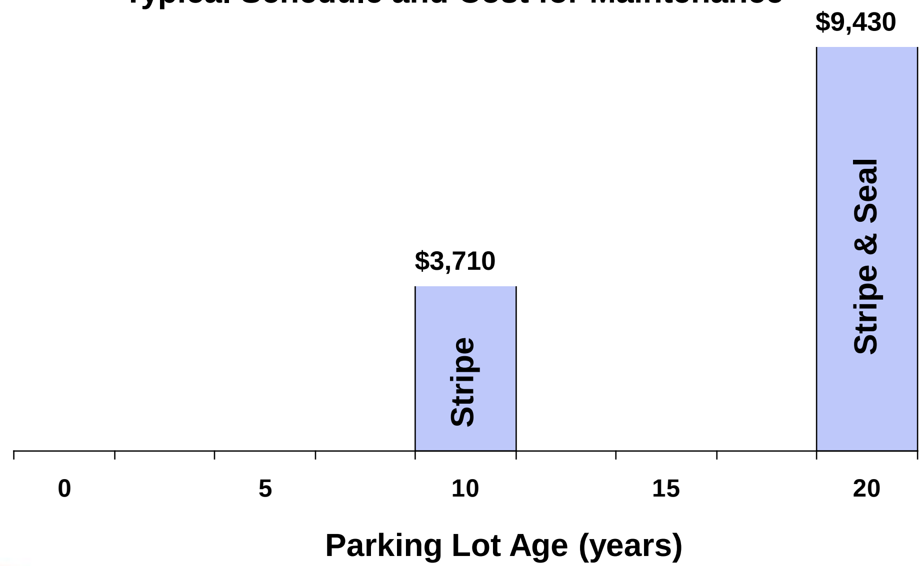
- **Surface needs to be degreased and restriped (every 10 years)**

Crack Seal

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

Crack Seal

Typical Schedule and Cost for Maintenance



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

ASPHALT MAINTENANCE IS REQUIRED OFTEN

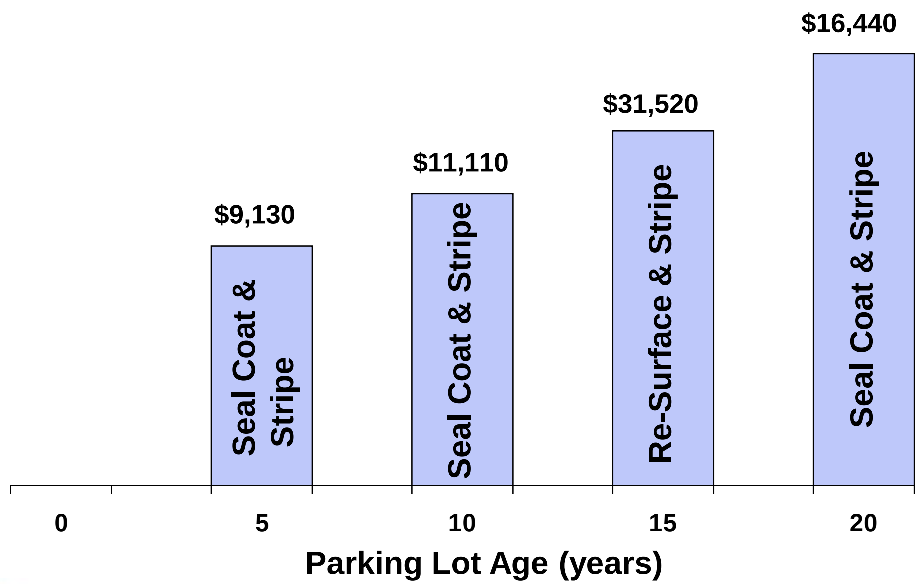
Seal Coat

Pavement Striping

Maintenance Interval

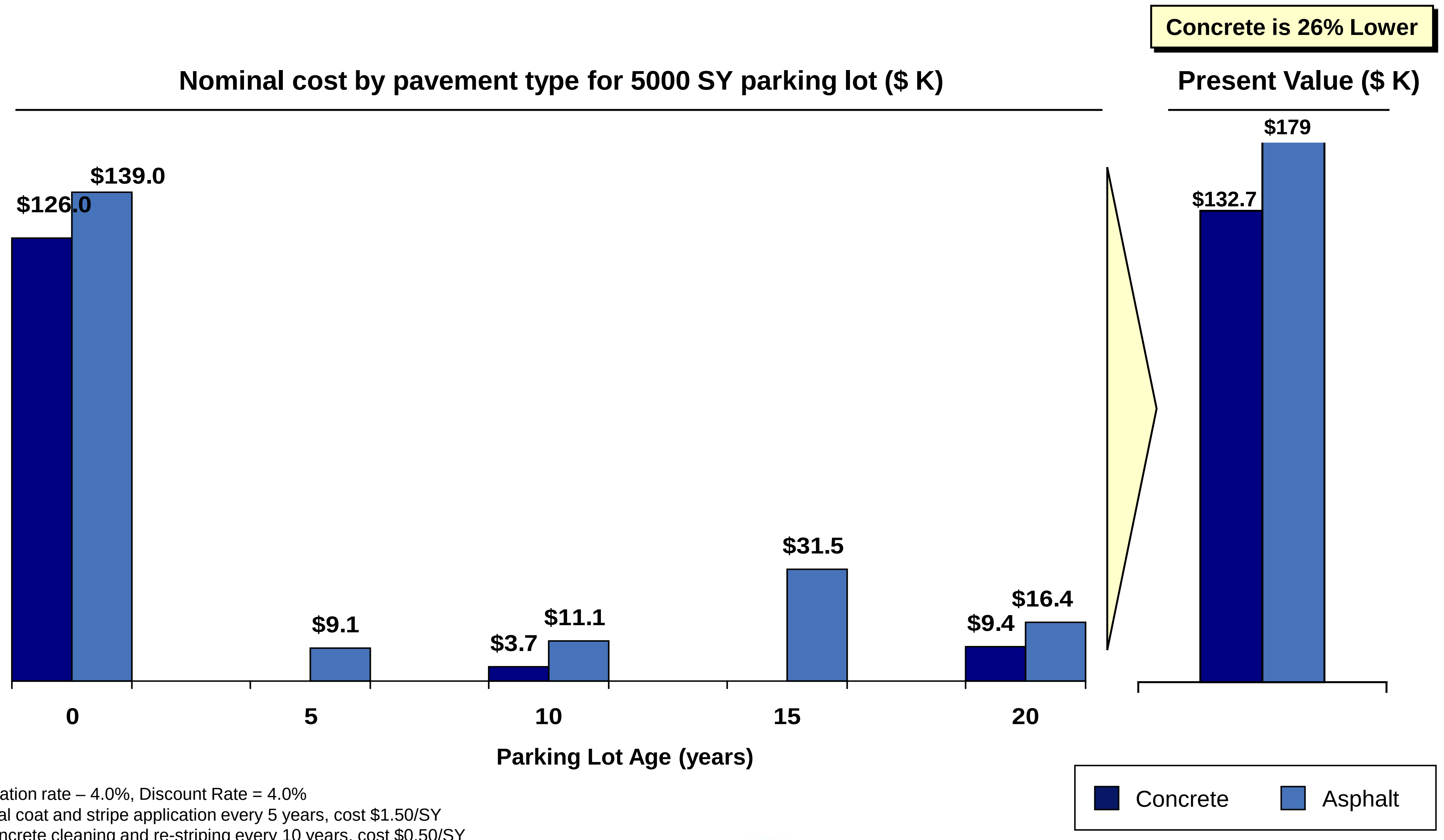
Seal coat and stripe
- Asphalt surface cracks, ravels, oxidizes
- Seal coat fills cracks and rejuvenates surface
- Apply every 3 to 5 years
  - Recommended by Asphalt Institute
- Expected cost $1.50/SY - $7,500/application[1] (current costs)

Typical Schedule and Cost for Maintenance



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

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



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

USING OTHER INDUSTRY RECOGNIZED PRACTICES CAN MAKE CONCRETE MORE COMPETITIVE

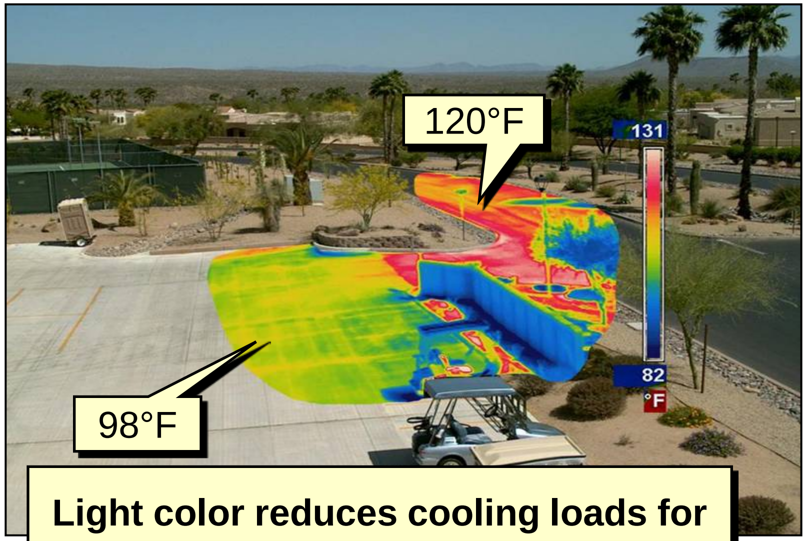
Element	Objective	Recommendation	Cost Impact
Pavement Thickness[1]	➢ Design thickness to match expected traffic ➢ ACI 330 Guide	➢ Do not use artificial minimums ➢ ACI 330 Guide	15-25%/inch
Granular Base	➢ Used to prevent pumping ➢ Used as construction platform	➢ Use in high truck traffic areas (>200/day)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

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 (CO_2, NOx, SOx, PM, VOC, smog)**



Light color reduces cooling loads for nearby structures

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

9:00 pm February Springfield, IL, 5 minutes of each other.
Same camera settings, same-size lots, same light poles

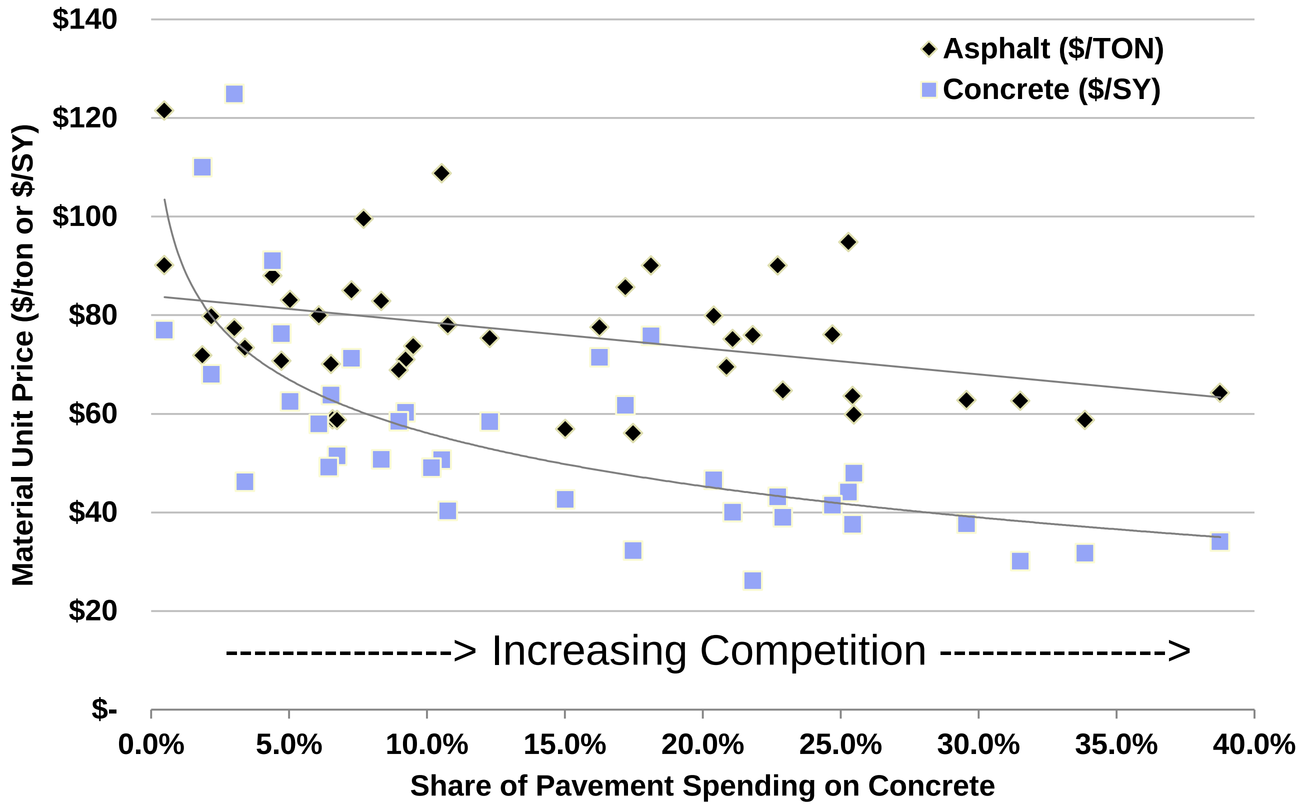
SUSTAINED COMPETITION BETWEEN THE PAVING MATERIALS INDUSTRIES BRINGS VALUE TO THE TAX PAYERS

- **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!**

Weighted unit costs versus five-year average balance of state pavement type usage (2009-2013Q3)



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…

Budget	Concrete Portion of Budget	Expenditure on Asphalt ($)	Asphalt Unit Price ($)	Tons of Asphalt	Expenditure on Concrete ($)	Concrete Unit Price ($)	Square Yards of Concrete
$200 M	0%	$200 M	$83.88	2,384,232	--	--	--
$200 M	5%	$190 M	$81.24	2,338,829	$10 M	$66.94	149,380
$200 M	10%	$180 M	$78.59	2,290,382	$20 M	$56.13	356,314
$200 M	15%	$170 M	$75.94	2,238,558	$30 M	$49.81	602,348
$200 M	20%	$160 M	$73.29	2,182,989	$40 M	$45.32	882,666
$200 M	25%	$150 M	$70.65	2,123,255	$50 M	$41.84	1,195,137
$200 M	30%	$140 M	$68.00	2,058,869	$60 M	$38.99	1,538,778
$200 M	35%	$130 M	$65.35	1,989,266	$70 M	$36.59	1,913,236

METHODS THAT INCREASE COMPETITION HAVE BEEN SHOWN TO LOWER PROJECT COSTS

29 states have used Alternate Design Alternate Bid at least once

	AD/AB Results
Indiana [1]	• Used on 64 projects • 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
Kentucky [2]	• Used on 44 projects, with a documented savings of $148M • 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
Louisiana [3]	• Used AD/AB on 47 projects between 2001 and 2009 • Cost savings of $120M on these 47 projects
Missouri [4]	• Used on 124 projects through July 2009 • ADAB yielded a 10% decrease in unit costs for both asphalt and concrete.
Ohio [5]	• Used on more than 10 projects • A industry study of five projects in let 2009 documented a savings of $58M
West Virginia [6]	• WV has used AD/AB on 13 projects • The state has documented a savings of $16.4M on their six most recent projects

Sources:

1. Alternate Bidding History and Requirements. Thomas L. Duncan, PE (FHWA) and David B. Holtz, PE (INDOT). March 2013
2. KYTC Alternate Bid Pavement Projects 2006-2012. Paul Looney, PE, KYTC Division of Highway Design Pavement Branch, March 2013
3. Alternate Design Alternate Bid - ADAB - Using Life Cycle Analysis. Bill Temple, Former Chief Engineer, LA DOTD, March 2010
4. MODOT Alternate Paving Approach. Dave Ahlvers, 2009 AASHTO Subcommittee on Construction, July 2009
5. New ODOT Policy on Alternate Bids. Roger Faulkner, PE. Director of Engineering & Promotion, Ohio Concrete. December 2010
6. Alternate Design Alternate Bid of Pavements in West Virginia. Joe H. Hall, PE, PS - WVDOT/DOH. December 2010

CEMENT-BASED PAVEMENT SOLUTIONS

	Conventional Concrete Pavements	Thin Concrete Pavements	Roller Compacted Concrete	Concrete Overlays	Cement Treated Bases	Soil Stabilization	Pervious Concrete
Highways	●		●	●	●	●	
Local Streets	●	●	●	●		●	●
Rural Roads	●		●			●	
Parking Lots	●	●	●	●		●	●
Bus Lanes	●	●		●	●	●	
Base Course			●		●	●	
Industrial	●		●	●	●	●	●
Airport Runways & Aprons	●			●	●	●	

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Bus Lanes	●	●		●	●	●	
Base Course			●		●	●	
Industrial	●		●	●	●	●	●
Airport Runways & Aprons	●			●	●	●	

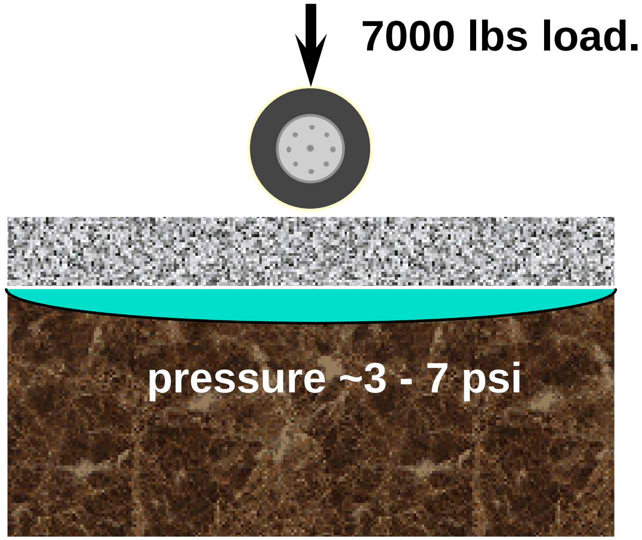
CONCRETE AND ASPHALT PAVEMENTS ARE DIFFERENT BASED ON HOW THEY DELIVER LOADS TO THE SUBGRADE

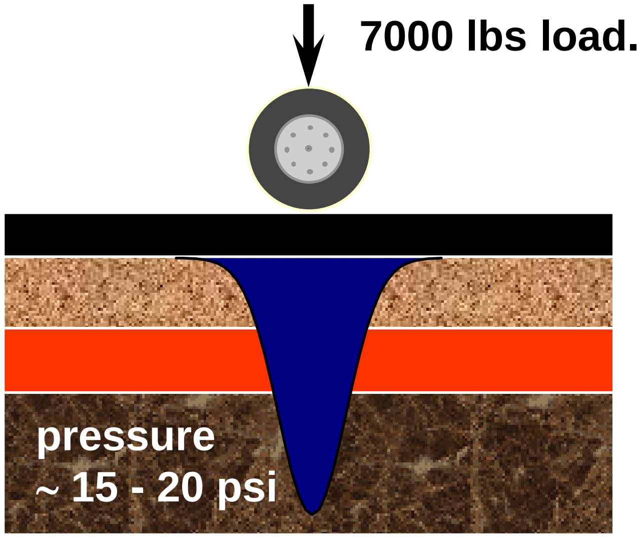
Concrete Pavements are rigid

- 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



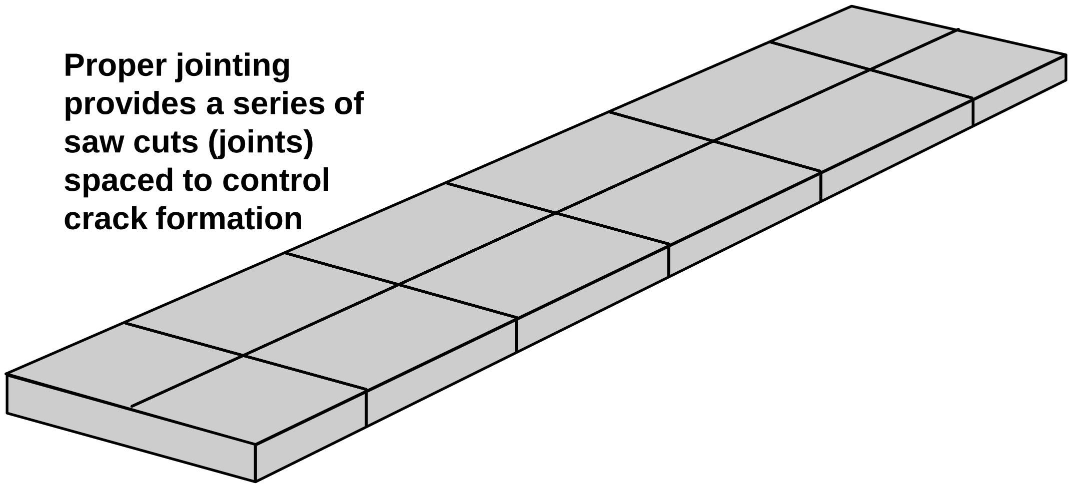


Concrete's Rigidity spreads the load over a large area & keeps pressures on the subgrade low

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

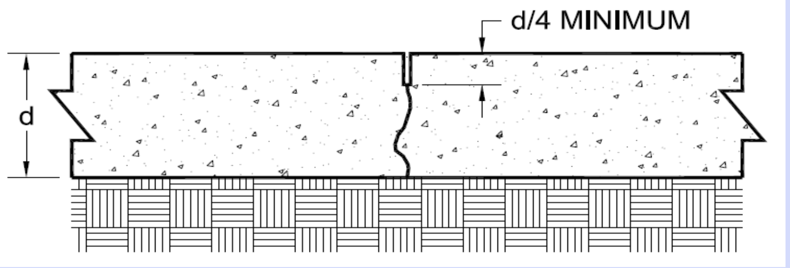
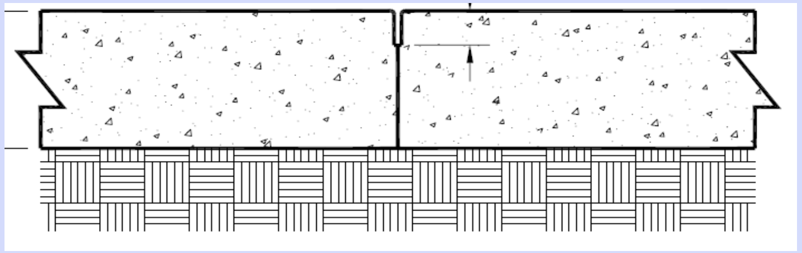
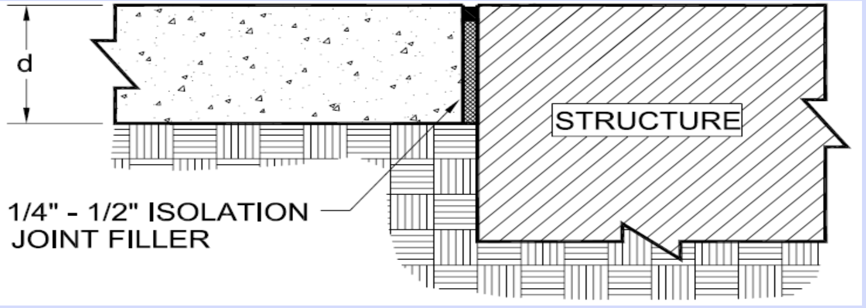


Erratic crack patterns due to no joints

Recommended Maximum Joint Spacing (2 x thickness in ft)

Pavement thickness, in.	Spacing range, ft
4 to 4.5	6-10
5 to 5.5	7.5 -12.5
6 or greater	10-15

TYPES OF JOINTS IN CONCRETE PAVEMENTS

	Details For Use	Typical Detail
Contraction (Control) Joint	➢ Use at short joint spacing ➢ Made by saw cut, or tooled ➢ Early entry cuts = 1" deep ➢ Saw cut within 2 to 6 hours of paving	
Construction Joint	➢ Use at end of construction day ➢ Use thickened edge for heavy duty applications ➢ Keyways not recommended	
Isolation (Expansion) Joint	➢ Isolate pavement features with differential movements ➢ Do not use at regular spaced joints in paving lane ➢ Full thickness, vertical joint, sealed with compressible material	

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?

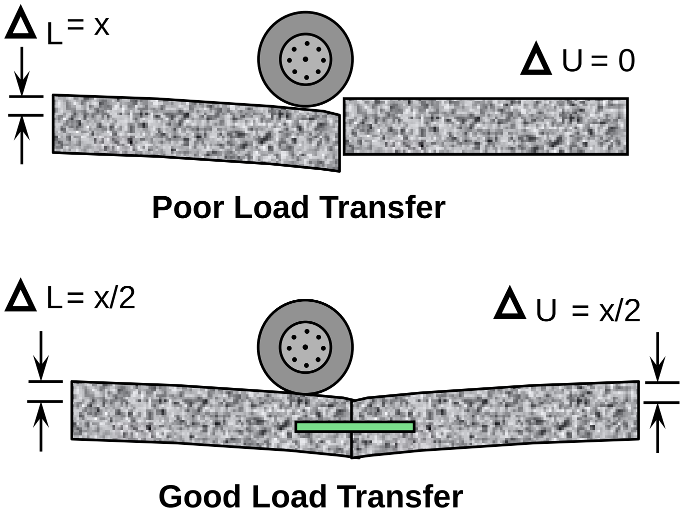
Dowels are used to improve Load Transfer

A slabs 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**



<u>Trucks Control Thickness and Deflections</u>

- **Include dowels if:**
  - **Slab thickness > 8.0 inches**
- **Exclude dowels if:**
  - **Slab thickness < 7.0 inches**

<u>Other issues:</u>

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

Conditions for Pumping

1. Subgrade soils that are erodible
2. Free water between slab and subgrade
3. Frequent heavy wheel loads

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

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Parking Lots	●	●	●	●		●	●
Bus Lanes	●	●		●	●	●	
Base Course			●		●	●	
Industrial	●		●	●	●	●	●
Airport Runways & Aprons	●			●	●	●	

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 Its is also used on city streets and Residential subdivisions. Go to rcc.acpa.org for projects examples

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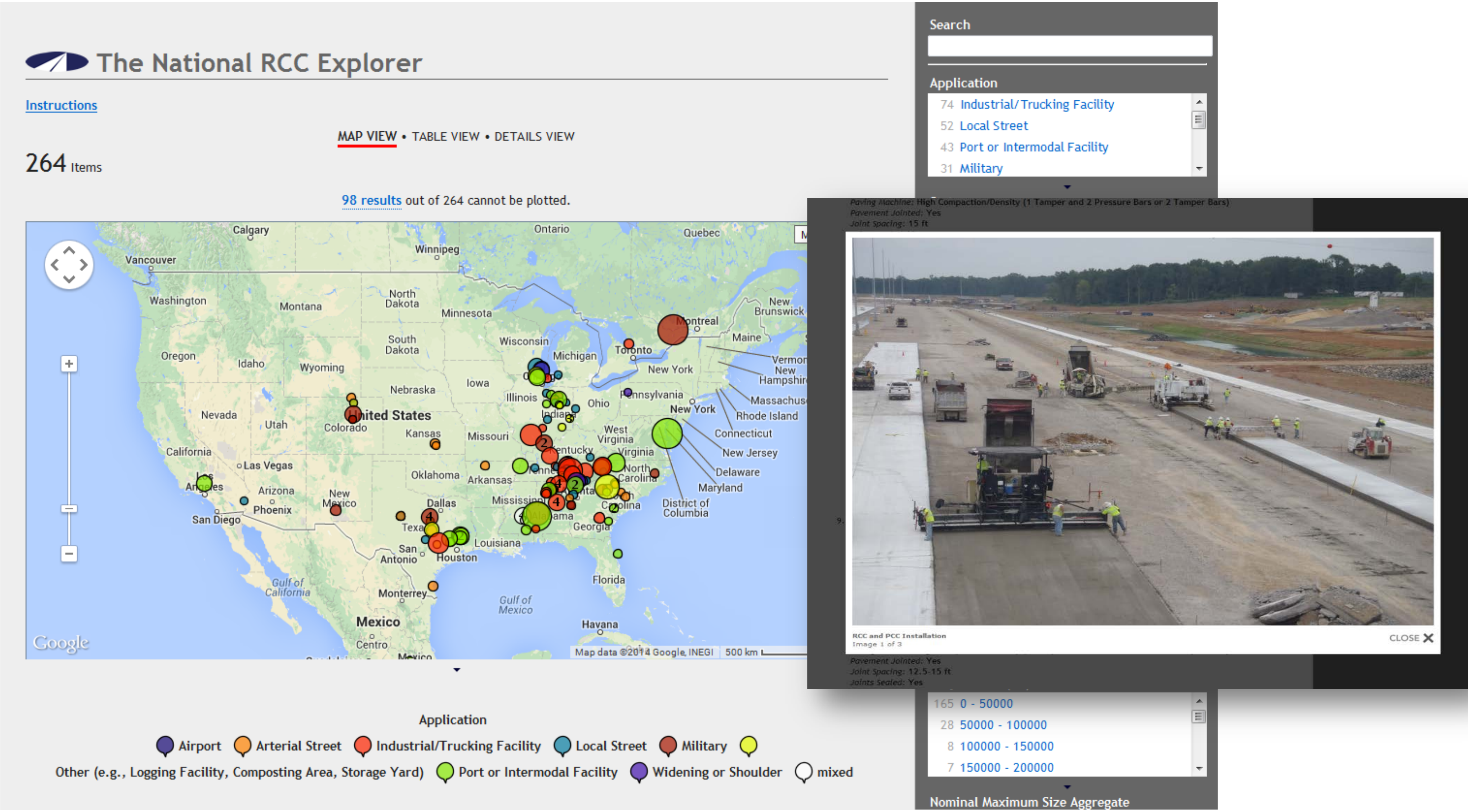
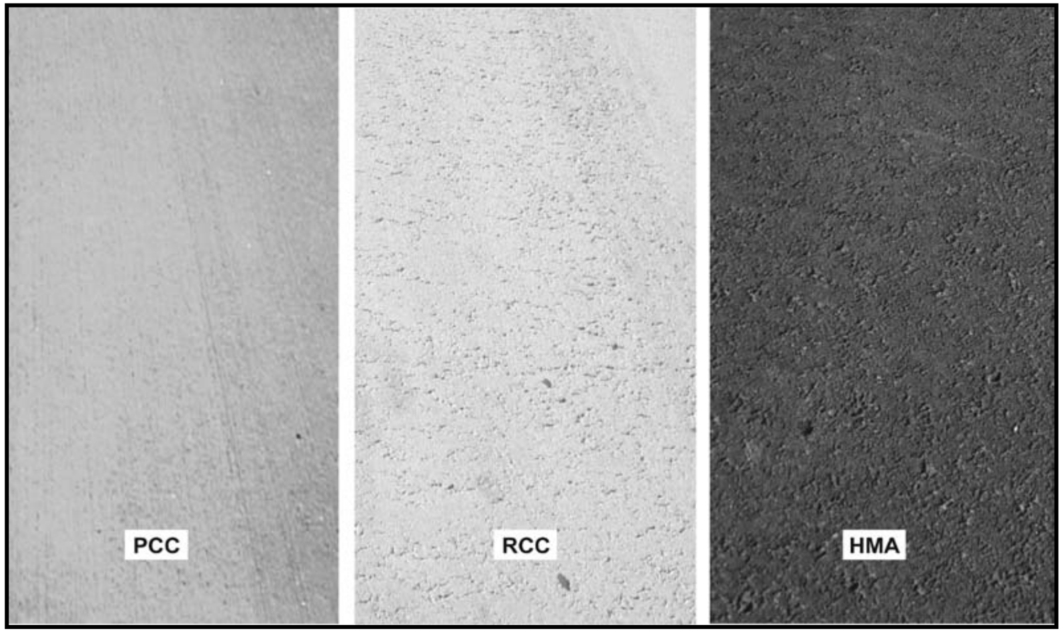
RCC EXPLORER DATABASE SHOWS WHERE RCC HAS BEEN DONE

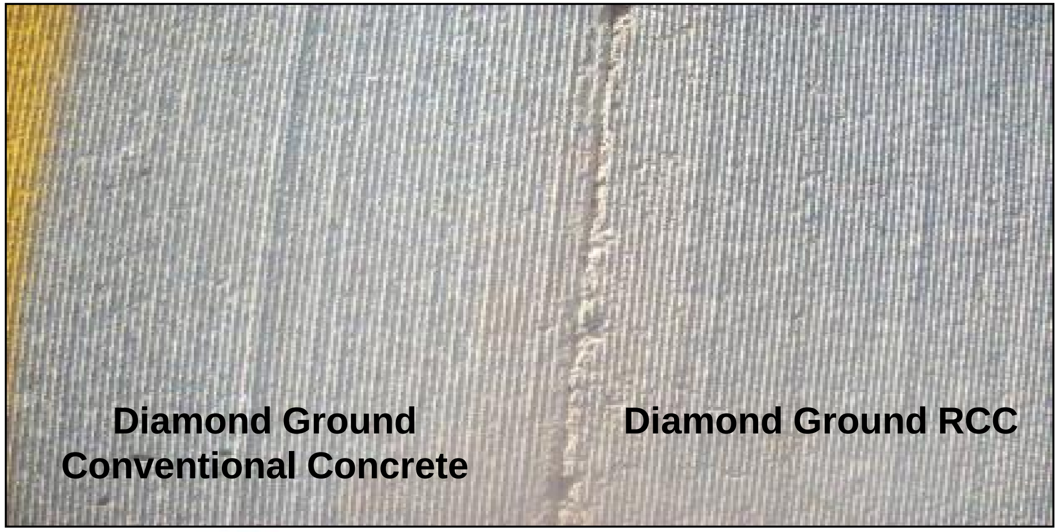
rcc.acpa.org



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**





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Airport Runways & Aprons	●			●	●	●	

CONCRETE OVERLAYS HAVE SIMILAR LONG-TERM DURABILITY AND COST ADVANTAGES OF TRADITIONAL CONCRETE PAVEMENTS

Durability & Costs Advantages

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

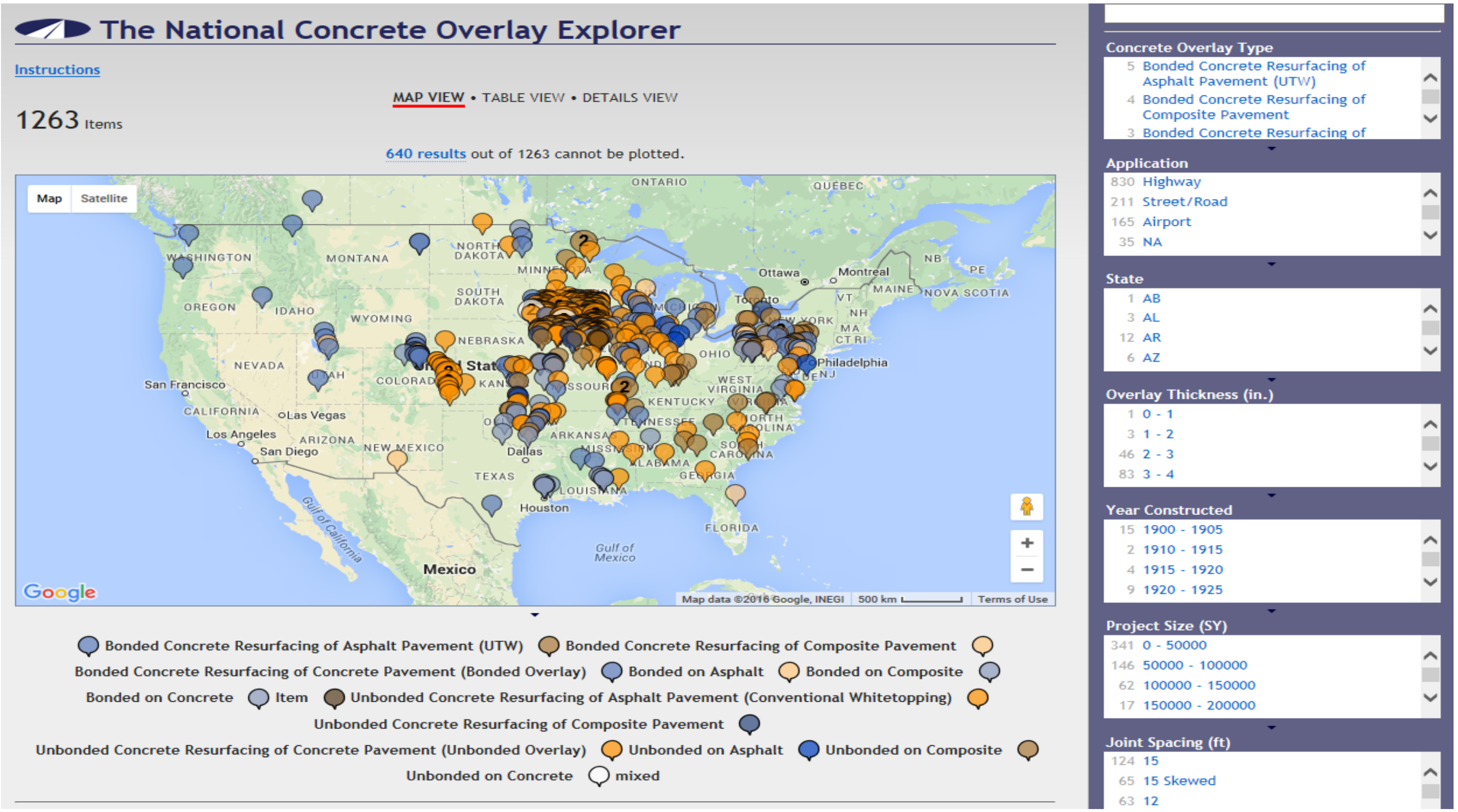
- Reduced pavement removal / use existing structure
- Uses fewer virgin materials
- High skid resistance and non-rutting
- High reflectivity = greater visibility, lower surface temperature
- Stiff system = better fuel efficiency
- Fewer construction emissions

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



http://overlays.acpa.org/webapps/overlayexplorer/index.html

Iowa [1,2]

- **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**

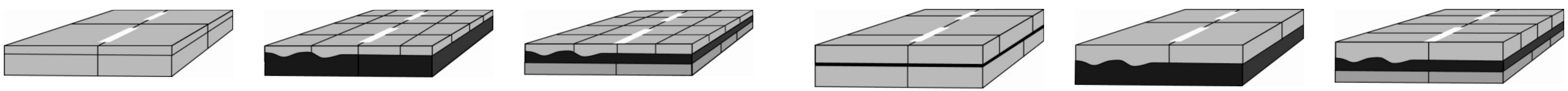
1. Iowa Concrete Pavement Association
2. National Concrete Pavement Technology Center (CPTech Center)

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

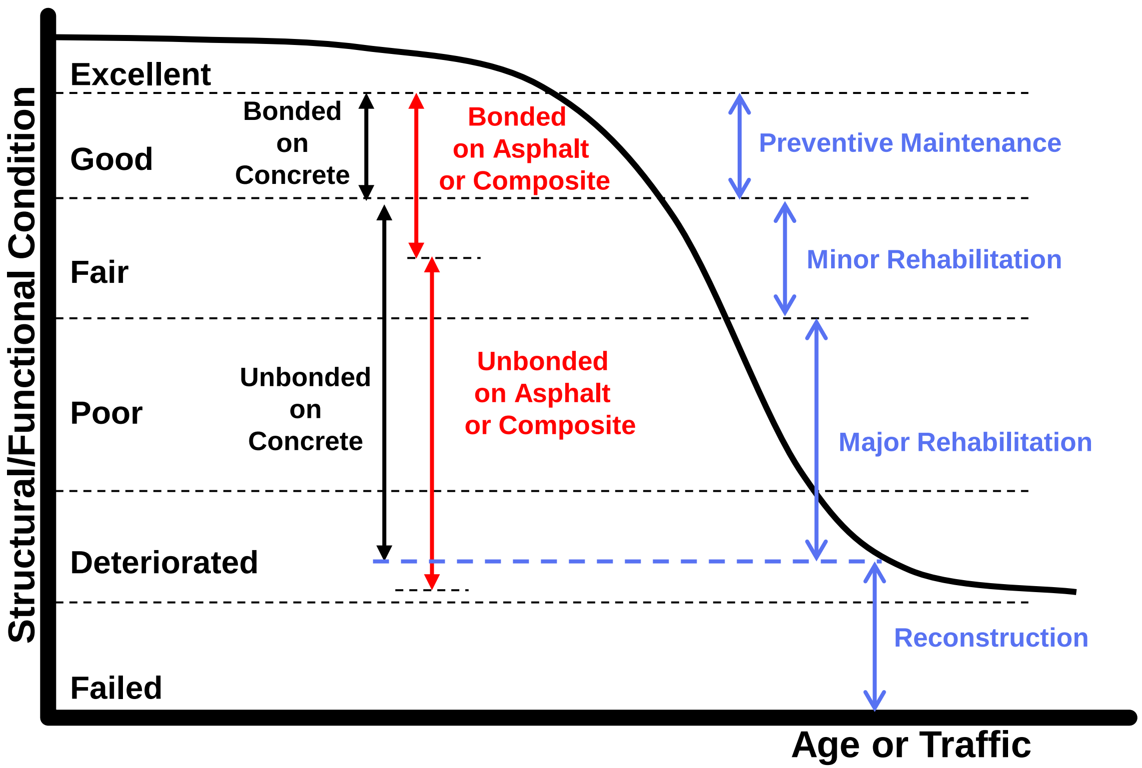


Bond is integral to design
(Existing pavement is in relatively good shape)

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

Pavement Deterioration Curve

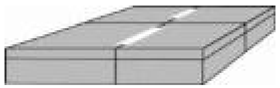
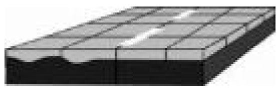
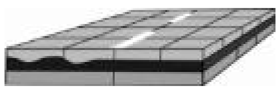
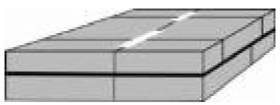
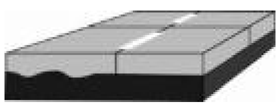
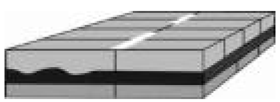


Other Issues that dictate viability of an overlay

- 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

	Typical Concrete Thickness for Urban Applications			Typical Concrete Thickness for Rural Applications		
	Interstate & Expressways	Principal & Minor Arterials	Collectors	Interstate & Expressways	Principal & Minor Arterials	Collectors
	2-4 in (50 to 100 mm)	2-4 in	2-4 in	2-6 in (50 to 150 mm)	2-4 in	2-4 in
		3-6 in (75 to 150 mm)	3-6 in		3-6 in	3-6 in
		3-6 in	3-6 in		3-6 in	3-6 in
	6-11 in (150 to 280 mm)	5-6 in (125 to 150 mm)	5-6 in	6-11 in	5-8 in (125 to 200 mm)	4-8 in (105 to 200 mm)
	6-11 in	5-6 in	5-6 in	6-11 in	5-8 in	4-8 in
	6-11 in	5-6 in	5-6 in	6-11 in	5-8 in	4-8 in

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)

CEMENT-BASED PAVEMENT SOLUTIONS

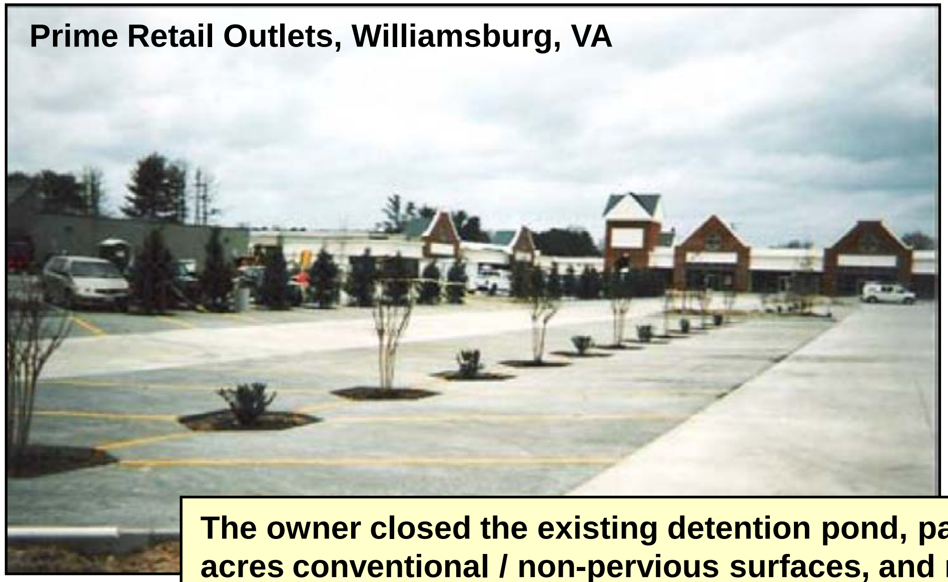
	Conventional Concrete Pavements	Thin Concrete Pavements	Roller Compacted Concrete	Concrete Overlays	Cement Treated Bases	Soil Stabilization	Pervious Concrete
Highways	●		●	●	●	●	
Local Streets	●	●	●	●		●	●
Rural Roads	●		●			●	
Parking Lots	●	●	●	●		●	●
Bus Lanes	●	●		●	●	●	
Base Course			●		●	●	
Industrial	●		●	●	●	●	●
Airport Runways & Aprons	●			●	●	●	

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]

1. National Ready Mixed Concrete Association (NRMCA) Presentation

WHERE HAS PERVIOUS CONCRETE BEING USED?

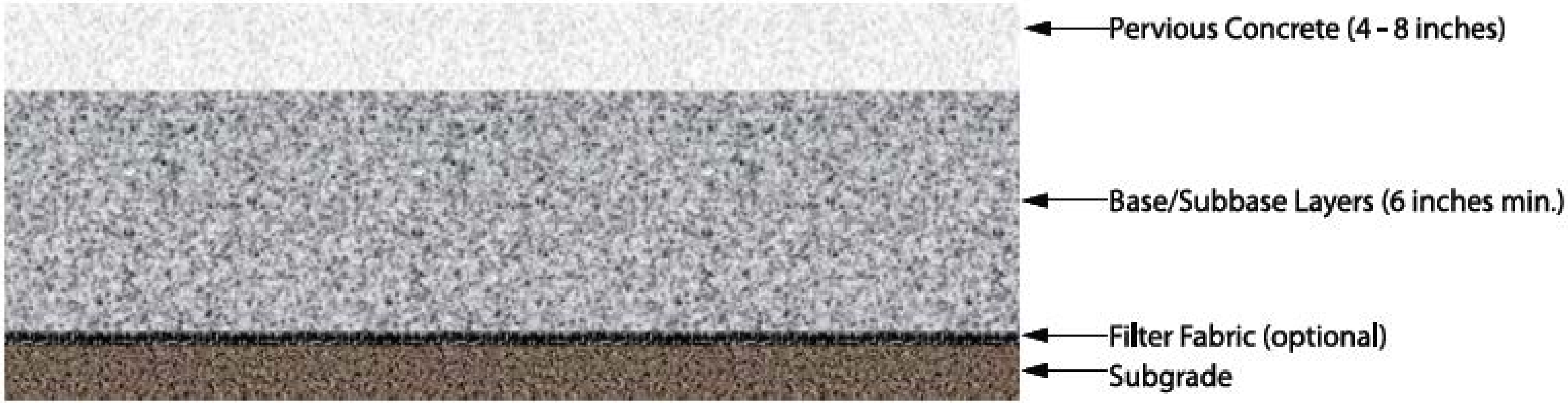
Streets and Roads

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

PERVIOUS CONCRETE DESIGN CONSIDERATIONS

1. Traffic:

- **Pedestrian/Sidewalk (typically 4 inches min.)**
- **Standard Duty Traffic (typically 6 inches min.)**
- **Heavy Duty Pavement (typically 8 inches min.)**

Sidewalk Pavement

Standard Duty Pavement

Heavy Duty Pavement

CEMENT-BASED PAVEMENT SOLUTIONS

	Conventional Concrete Pavements	Thin Concrete Pavements	Roller Compacted Concrete	Concrete Overlays	Cement Treated Bases	Soil Stabilization	Pervious Concrete
Highways	●		●	●	●	●	
Local Streets	●	●	●	●		●	●
Rural Roads	●		●			●	
Parking Lots	●	●	●	●		●	●
Bus Lanes	●	●		●	●	●	
Base Course			●		●	●	
Industrial	●		●	●	●	●	●
Airport Runways & Aprons	●			●	●	●	

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

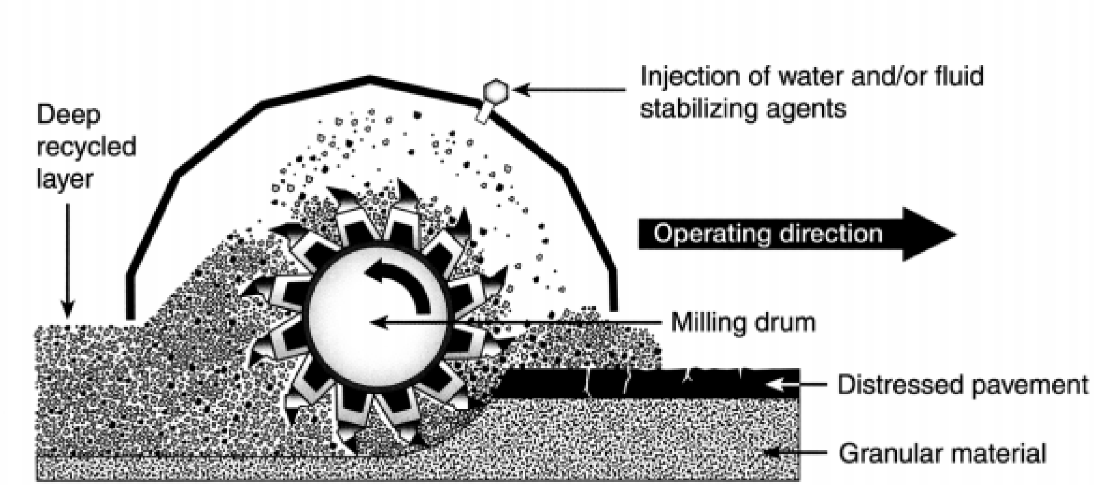
(1) PI – Plasticity index – measure of soil plasticity. Low PI = Sand, High PI = Clay
(2) Majority of soil stabilization is done on mid to high PI soils

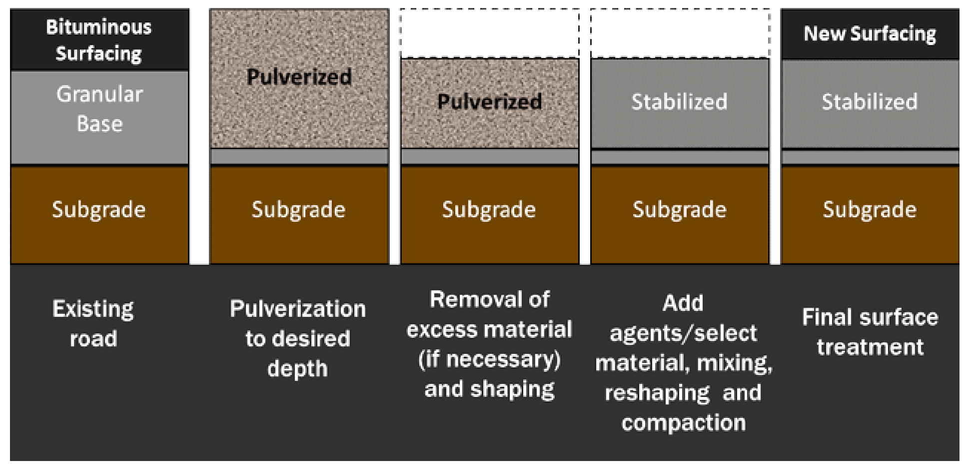
FULL-DEPTH RECLAMATION (FDR) WITH CEMENT

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.

Chunchula-Georgetown Road – Mobile County, AL
5Miles/948 Tons of Cement/64,500 SY





Thank You

& Any Questions?

Shadrack Mboya, P.E.
shadrack.mboya@cemex.com
Office: 205-986-4838
Cell: 205-999-8306