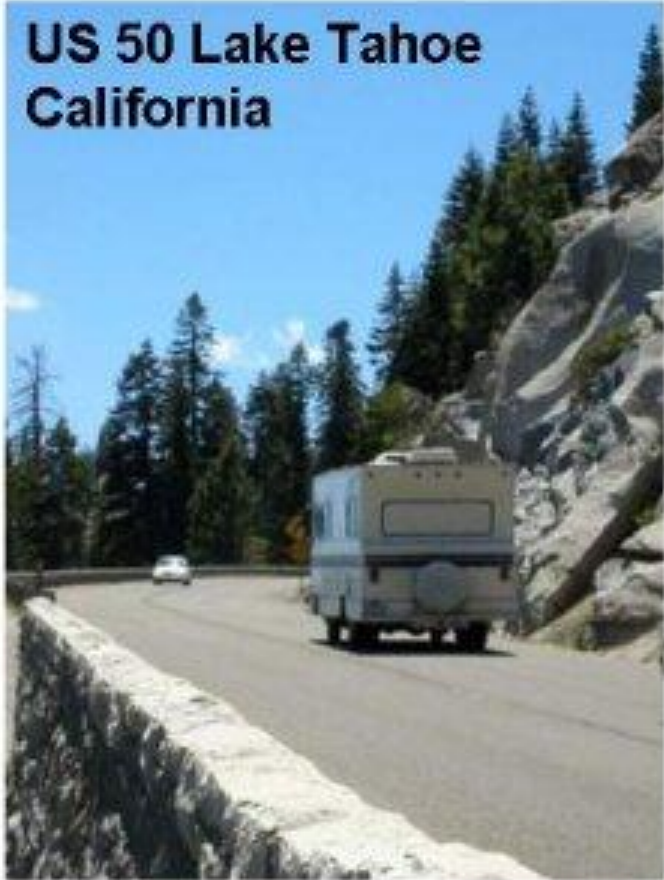


Bonded Wearing Course and Bonded Pavements



Road Science, LLC™



A Solution

For Lower Life Cycle Cost,
Longer Lasting Roads

Problems:

- Noisy pavements
- Overhead clearances, curb reveal
- Backspray visibility
- Loss of macro-texture
- Long construction delays
- Need for cost effective surfacing

Solution: Bonded Wearing Course



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What is BWC?

Hot mix asphalt surface treatment

- Preventive maintenance
- Corrective maintenance
- Surface for new pavements
- Over PCC or asphalt pavements
 - ~50% of projects over PCC, ~50% over asphalt

Single pass system

- Polymer modified emulsion membrane
- Thin gap graded hot mix
- Placed with spray paver



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A Little History. . .

1988 - First Trial in France

1992 - Introduced in U.S

1992 - Projects in TX & AL

1993 - Projects in NJ & PA

1993-97 - Projects in Northeast

1998 - Process adapted & spread throughout U.S.



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Spray Paver

3 Processes

- Spray emulsion
- Lay hot mix
- Smooth the mat



Application
of emulsion

Application
of HMA



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Spray Paver

Thin mat overlay

60-100 ft/min

Minimum of stops

Uniform application of emulsion



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Polymer Modified Emulsion

**Special polymer membrane
Controls migration into mix**

Superior bonding

- Allows thin lifts without
- delamination

Seals existing pavement



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The Hot Mixed Asphalt

High quality aggregate

- Durable macro-texture & skid resistance

Gap graded

Mix designed for process



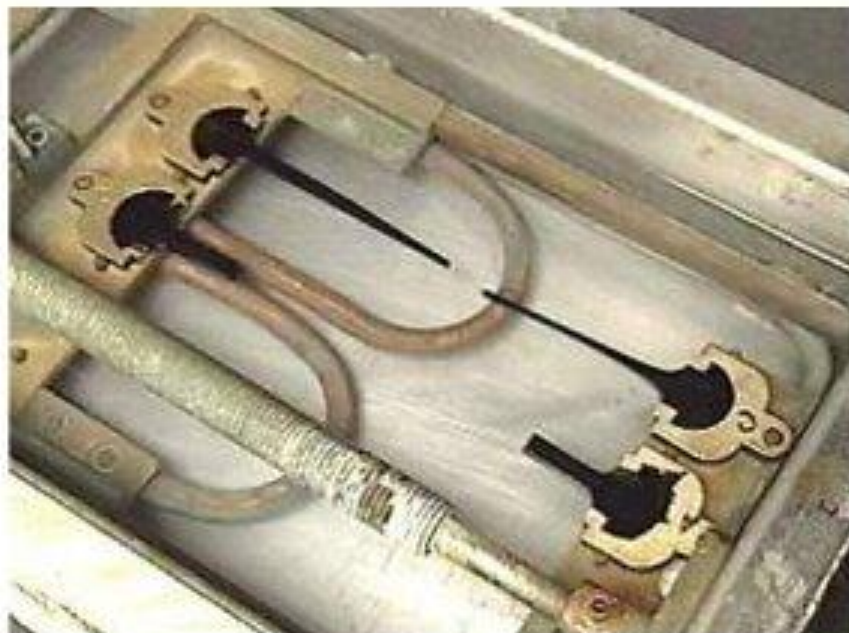
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The HMA Binder

PG binders

Polymer modified asphalt binders

- Less draindown
- Quicker traffic return
- Improved adhesion
- Less water sensitivity
- Better cracking resistance
- More durable



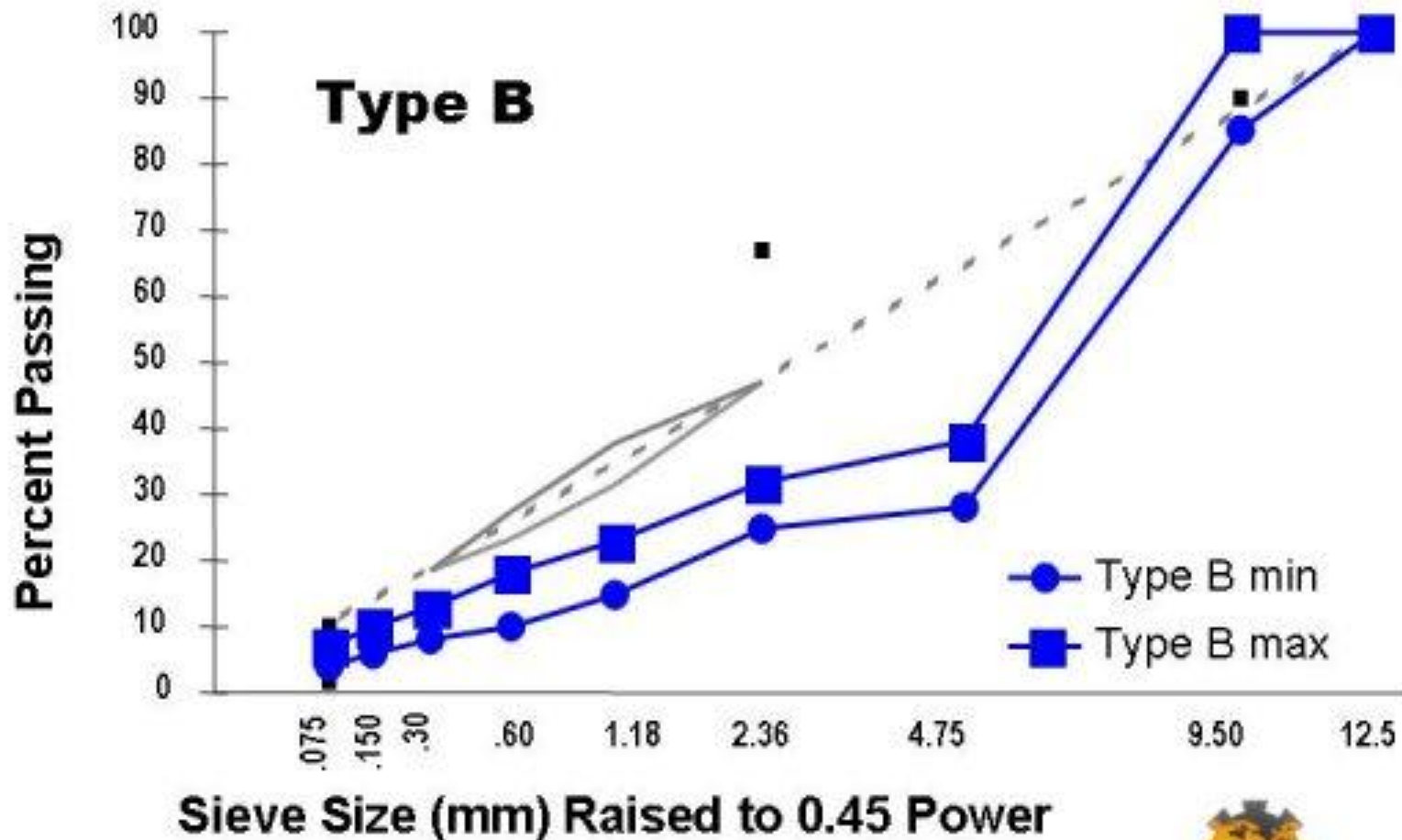
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Gap Graded

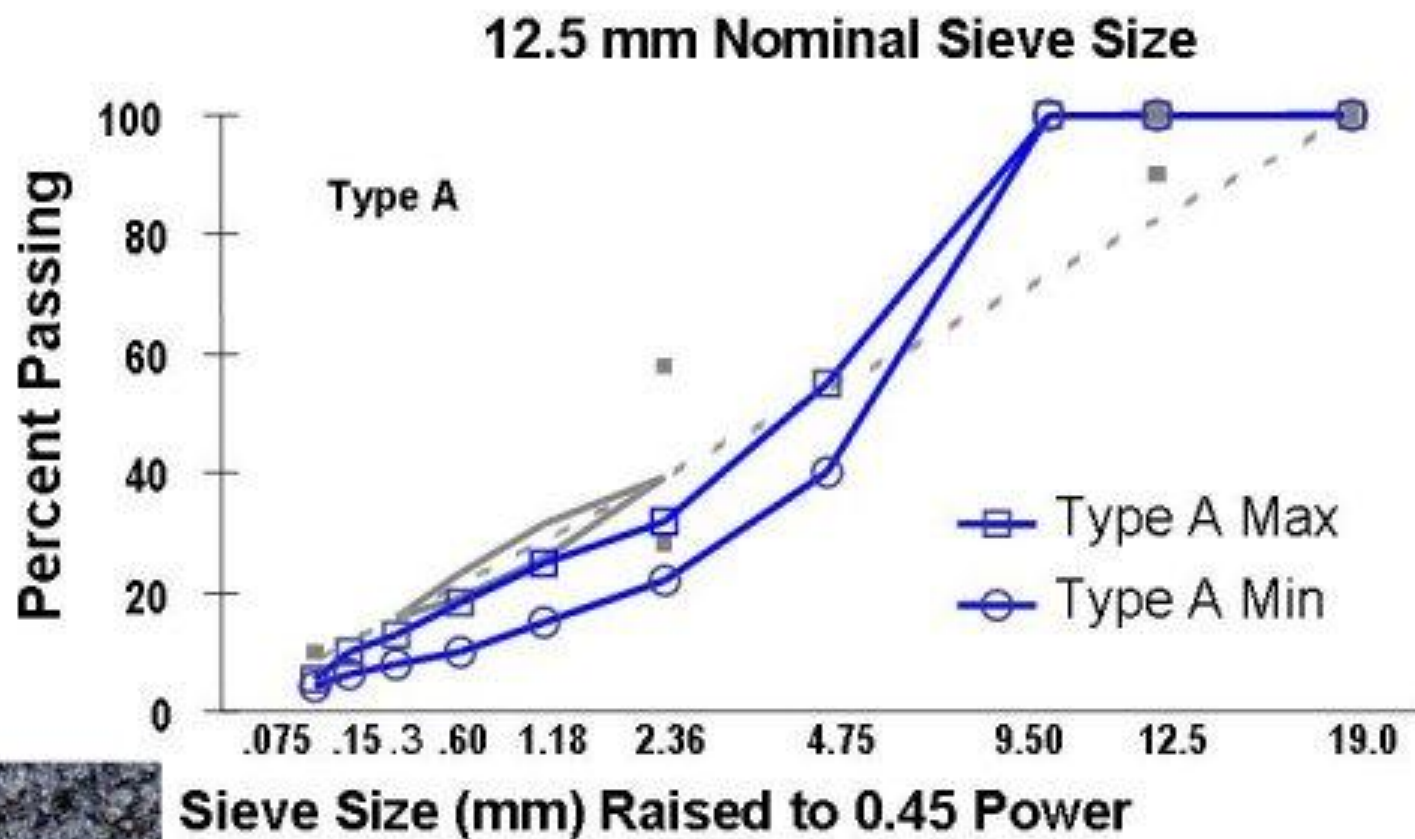
- Similar to Stone Matrix Asphalt gradation
- Enough space for polymer modified asphalt emulsion membrane
- Insures stone on stone contact
- Allows moisture to drain off
- Fines are part of asphalt binder mastic



Typical Aggregate Gradation

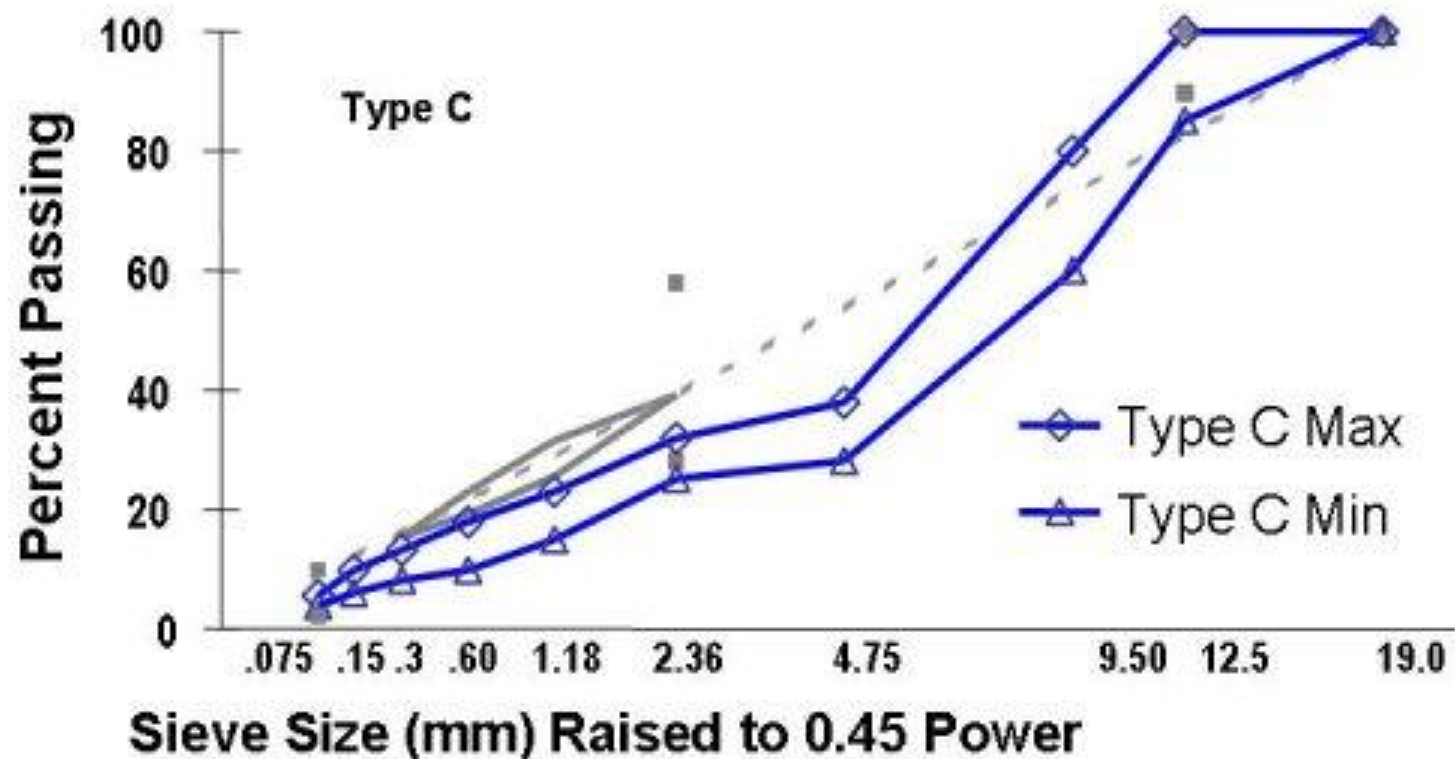


Other Typical Gradations



Other Typical Gradations

12.5 mm Nominal Sieve Size



Open Graded Friction Courses (OFGC)

- Permeable friction course
- Porous friction course
- Wet process crumb rubber open graded and gap graded mixes
- Terminal blend crumb rubber open graded and gap graded mixes



Typical Coarse Aggregate Specifications

Los Angeles abrasion value ¹ , % loss		35 max
Soundness ¹ , % loss	Magnesium Sulfate <u>or</u>	18 max
	Sodium Sulfate	12 max
Flat & Elongated Ratio at 3:1		25% max
% Crushed, single face		95 min
% Crushed, ≥ 2 mechanically crushed faces		85 min
Micro-Deval, % loss		18 max



*¹LA & Soundness targets for selection
Not sole basis for rejection*



Typical Fine Aggregate Specifications

Sand Equivalent

45 min

Methylene Blue (materials passing 200)

10 max

Uncompacted Void Content

40 min



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The Process (Type B)

The emulsion membrane “wicks up”
around the HMA aggregates

The emulsion cures,
bonding the mix & pavement



The Process



Performance



US 281 San Antonio, TX after 12 years



Reduced Tire Splash



Backspray from dense graded surface



Reduced backspray on Bonded Wearing Course

Results depend upon quality and gradation of aggregates used



Road Science, LLC^{TM23}

I-81 Virginia



Dense graded surface



Ultrathin Bonded Wearing Course

Results depend upon quality and gradation of aggregates used



Road Science, LLC^{TM24}

Open Mix Surfaces

Reduce noise

Minimize backspray

Increase visibility



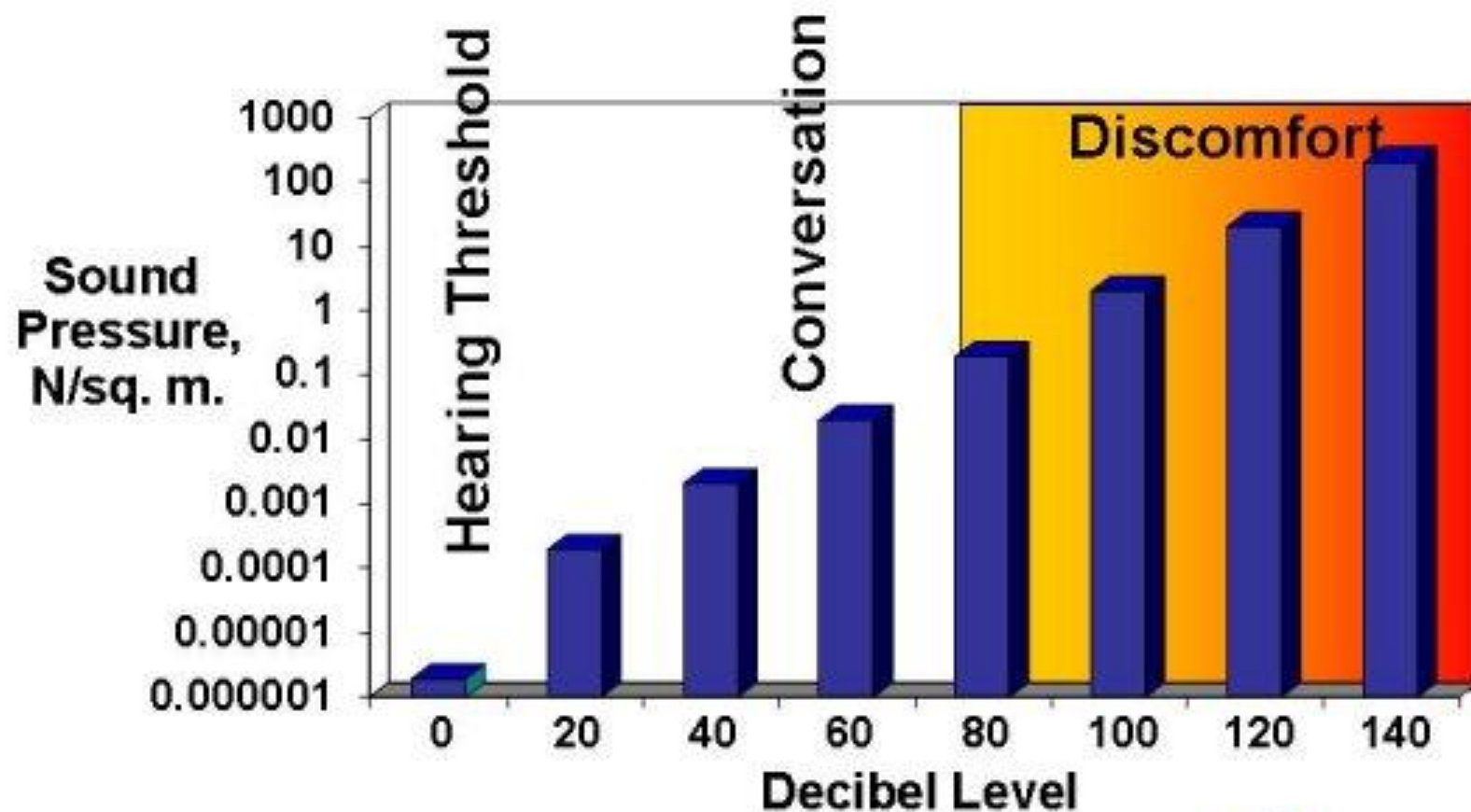
Courtesy Asphalt Institute



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How Do We Quantify Noise?

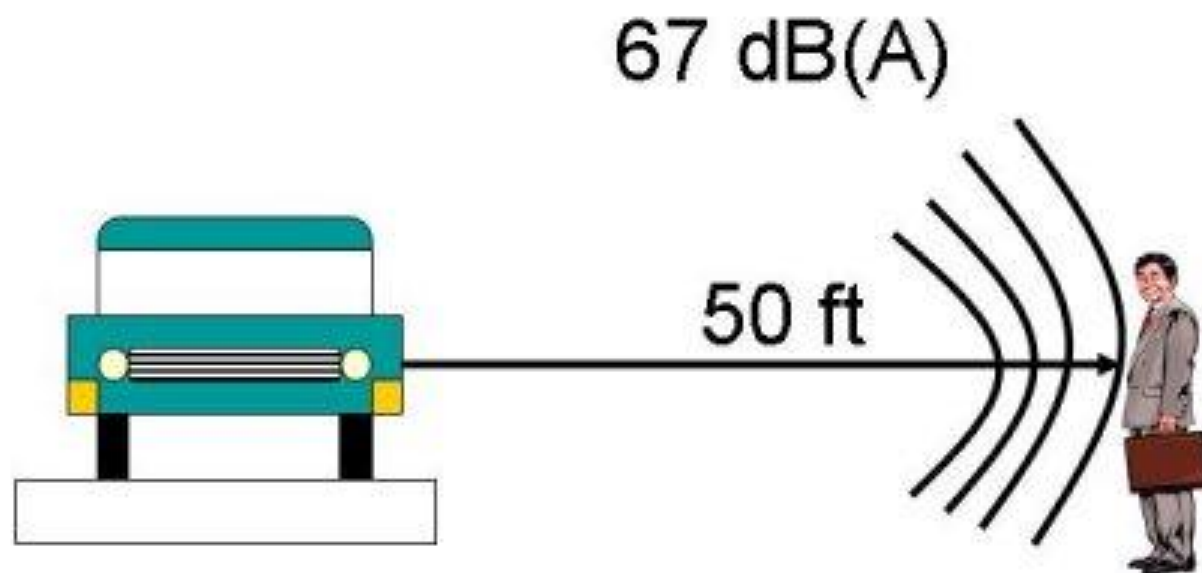
The Decibel Scale



Logarithmic scale

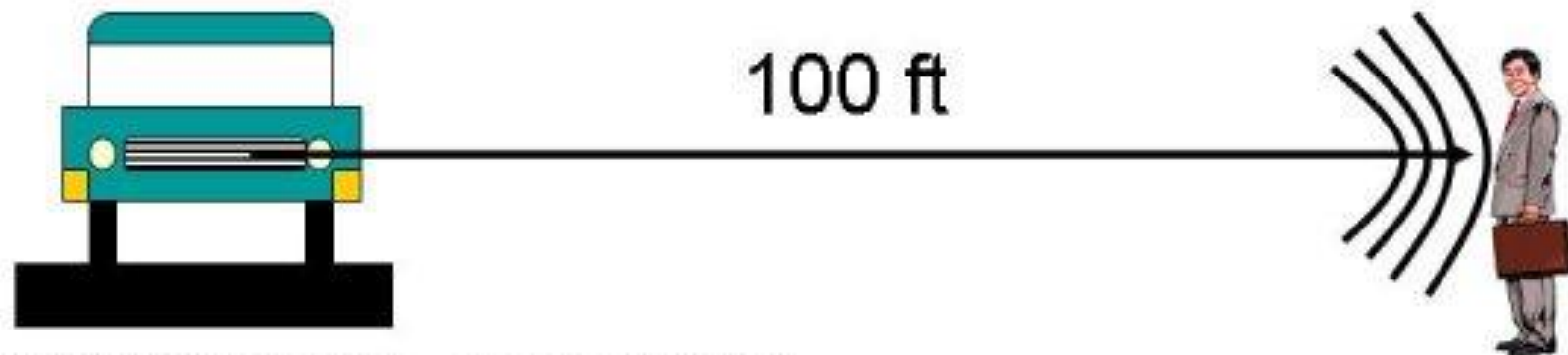


The Decibel Scale



Reduction of 3 dB(A) is Like Doubling Distance From the Noise

$$67 \text{ dB(A)} - 3 \text{ dB(A)} = 64 \text{ dB(A)}$$



A 3dB(A) reduction corresponds to:

- Doubling the distance
- Reducing traffic volume by 50%
- Reducing traffic speed by 25%



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Reduced Tire Noise

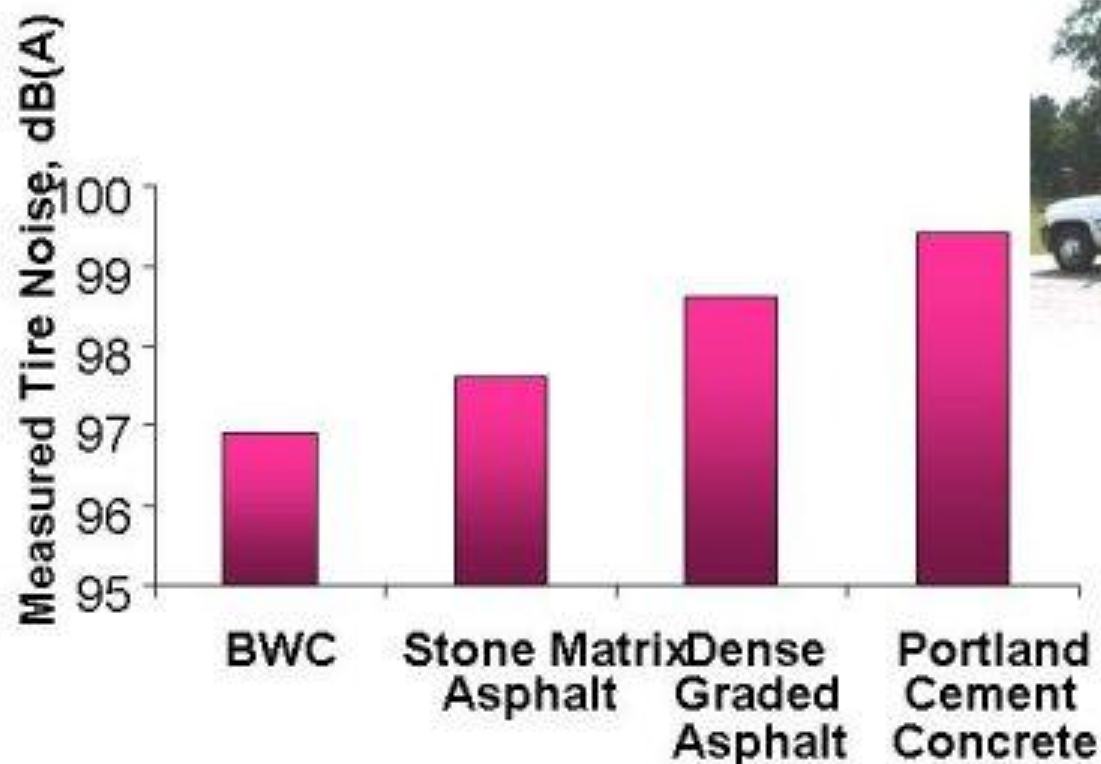
Garden State Parkway New Jersey (150,000 ADT)	Reduction in measured noise level by NovaChip surfacing
Over PCC	3.2 – 4.1 dB
Over bituminous pavement	1.4 – 2.1 dB

Schmidt & Fischer, TRB, 1994



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NCAT Noise Study for Michigan DOT



Average of measurements at 60 mph
12 pavement surfaces in Michigan
2 types of tires



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Durable Skid Resistance

PA SR 422

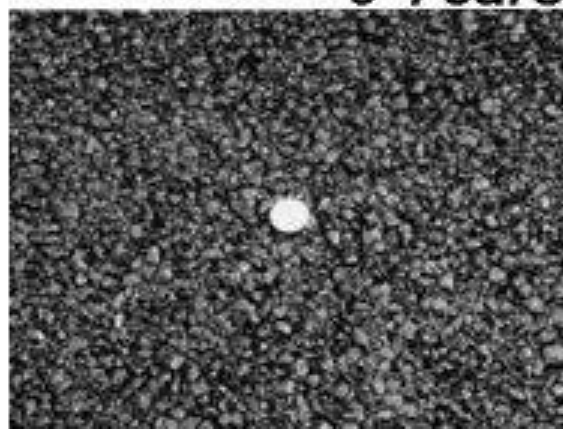
(28,000 ADT, 8% trucks)

UTBWC Over PCC

<i>When tested</i>	<i>Ave. Skid # ASTM E-274</i>
Before	27
After	46
+ 1 yr	56
+ 2 yrs	54
+ 5 yrs	57

Pavement Skid Friction - Pennsylvania SR 512

	NB	SB
Pre UTBWC	49	48
After UTBWC	46	44
1 Year	54	53
2 Years	54	53
3 Years	60	59
4 Years	58	58
5 Years	55	55



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Other Benefits

Protects pavement

- Seals out water
- Resists wear & rutting
 - Projects have lasted 10+ years with crack sealing
- Resists top-down cracking

Thin lift retains clearances, curbs

Fast construction reduces user delay

Night construction

Lower life cycle costs

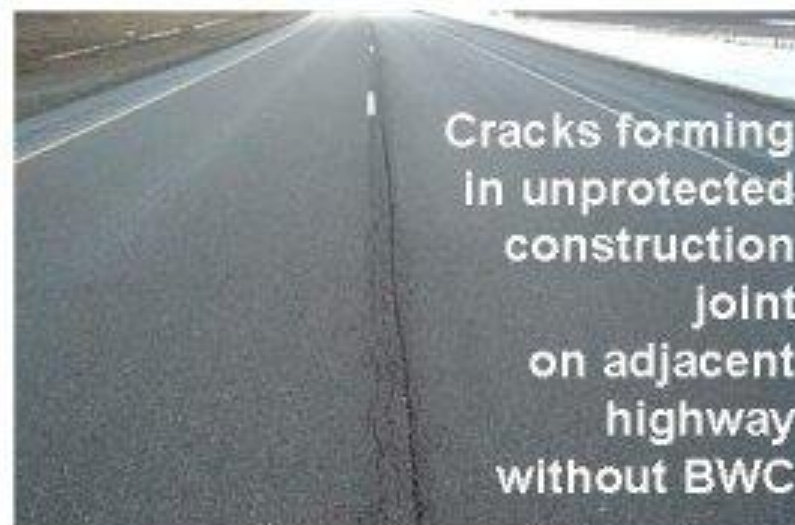


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Bonded Wearing Course Over Reconstruction

I-35, north of Albert Lea, MN

Seals and protects construction joints



I-35 after 2½ years



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Field Trial Research Reports

Caltrans Technical Advisory Guide

Louisiana Transportation Research Center (LTRC) at LSU

Texas Transportation Institute (TTI) at Texas A&M

**National Center for Asphalt Technology (NCAT) at Auburn
University**

Pennsylvania DOT

Mississippi DOT

New Jersey Garden State Parkway

Transportation Research Board (TRB) Record 2001



Road Science, LLC™

Projects



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City of Lancaster, California



Residential neighborhood construction



Residential Cul-de-sac





Brown Deer, WI



Kent County, MI



St. Paul, MN



I-85 North Carolina

San Jose, CA



Birmingham, AL



NCAT Test Track

Restoring Skid Resistance
1st Maintenance Treatment



Polished
surface
prior to
surfacing



UTBWC
surface



**“Excellent performance after 2,400,000
ESALs, and still going”**



Road Science, LLCTM 40

US 24

Colorado Springs, CO



Road Science, LLC™ 41

US 25 Kentucky



Hanging Lake Tunnel, I-70

Glenwood Springs, CO



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Harmon St. Las Vegas, NV

Over New Construction



Clark County Nevada

Ultrathin Bonded Wearing Course
Over New Construction

Surface characteristics

- Open graded
- Bonded

Durability

- Longest lasting surface treatment

Polymer emulsion membrane seals & protects

- Seals surface imperfections
- & cold joints

Structural addition

- Structural layer coefficient = 0.45



Road Science, LLCTM45

US 50 Lake Tahoe, CA

After 2 Years of Chains, Traffic & Snowplows



**With Bonded
Wearing Course**



**Without Bonded
Wearing Course**



Los Angeles County, CA



Night Paving



San Antonio, Texas



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I-20/59 Birmingham, AL

160,000 ADT

Before surfacing



After 3 years



Road Science, LLC™ 49

I-35E Denton, Texas



I-85 North Carolina

after 1 year



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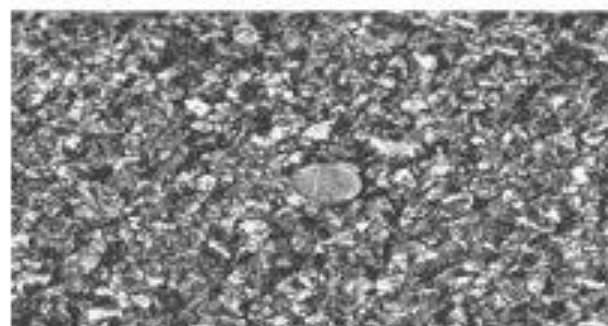
Stiles Rd Savannah, GA



After 1 year



After 2 years



I-40 North Carolina



After 4 years



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I-440 & I-64 North Carolina

Over PCC After 3 years



SR 1/64 Raleigh, NC



After 7 years



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Rt. 422 Pennsylvania



After 10 years



Where do you place BWC?

Site Selection Guidelines over Asphalt Pavements

Structurally sound pavement

Rut depth < 12.5 mm or ½ inch

Minor to moderate severity transverse & longitudinal cracking

Minor to moderate severity patches & bleeding

Raveling & polished aggregate to high severity



Where do you place BWC?

Site Selection Guidelines over PCC

Structurally sound pavement

Low severity “D” cracking

Minor to moderate transverse & longitudinal cracking

Minor to moderate severity corner breaks

Minor to moderate severity joint spalling

Map cracking < 10 m² in any 100 m² area

Faulting < 9.5 mm

**No blowups, water
bleeding or pumping**

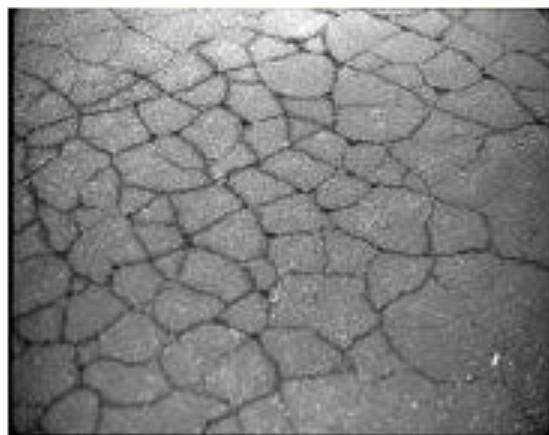


I-40 North Carolina



Poor Candidates for Maintenance BWC

Possible candidates for Rehab Bonded Pavement



High severity alligator cracking



High severity block cracking



Rutting



High severity "D" cracking



Pavement Preparation

Clean pavement

Seal existing cracks $> \frac{1}{4}$ inch

- Don't overfill

Fill surface deformities $> \frac{1}{2}$ inch deep

Protect manhole covers, drains, etc.

Remove pavement markings if possible (for best ride quality)



Preventive Maintenance

I-70 Kansas



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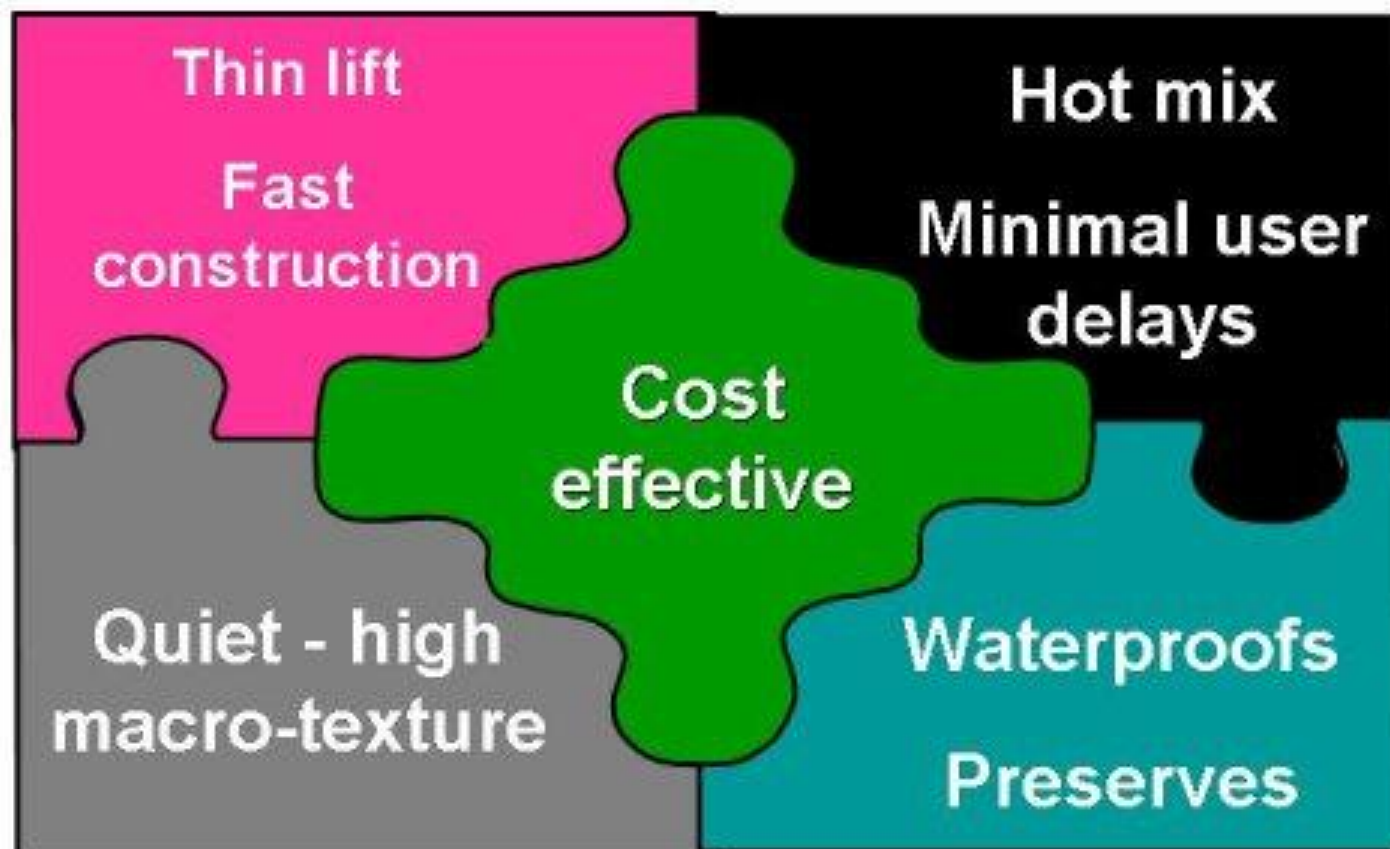
Rte. 288 Virginia

Over New Construction After 1 Year



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Summary



Thank you.

Questions?

