

HMA Quiet Pavement Overview: Causes and Cures

Southeast States Pavement
Management and Design Conference
Panama City, Florida

May 8-10, 2006

Mark Swanlund

Office of Pavement Technology

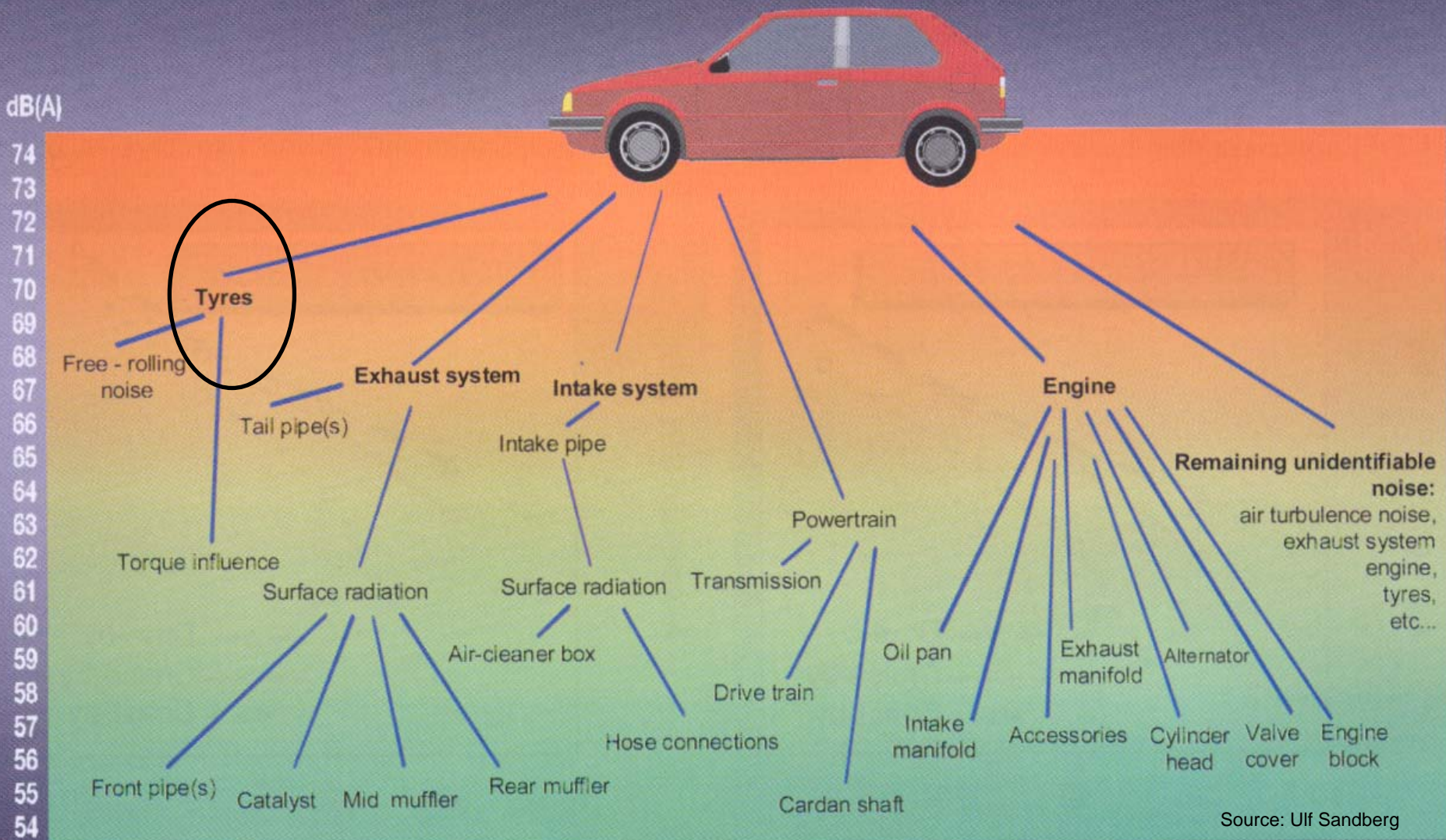


Presentation Outline

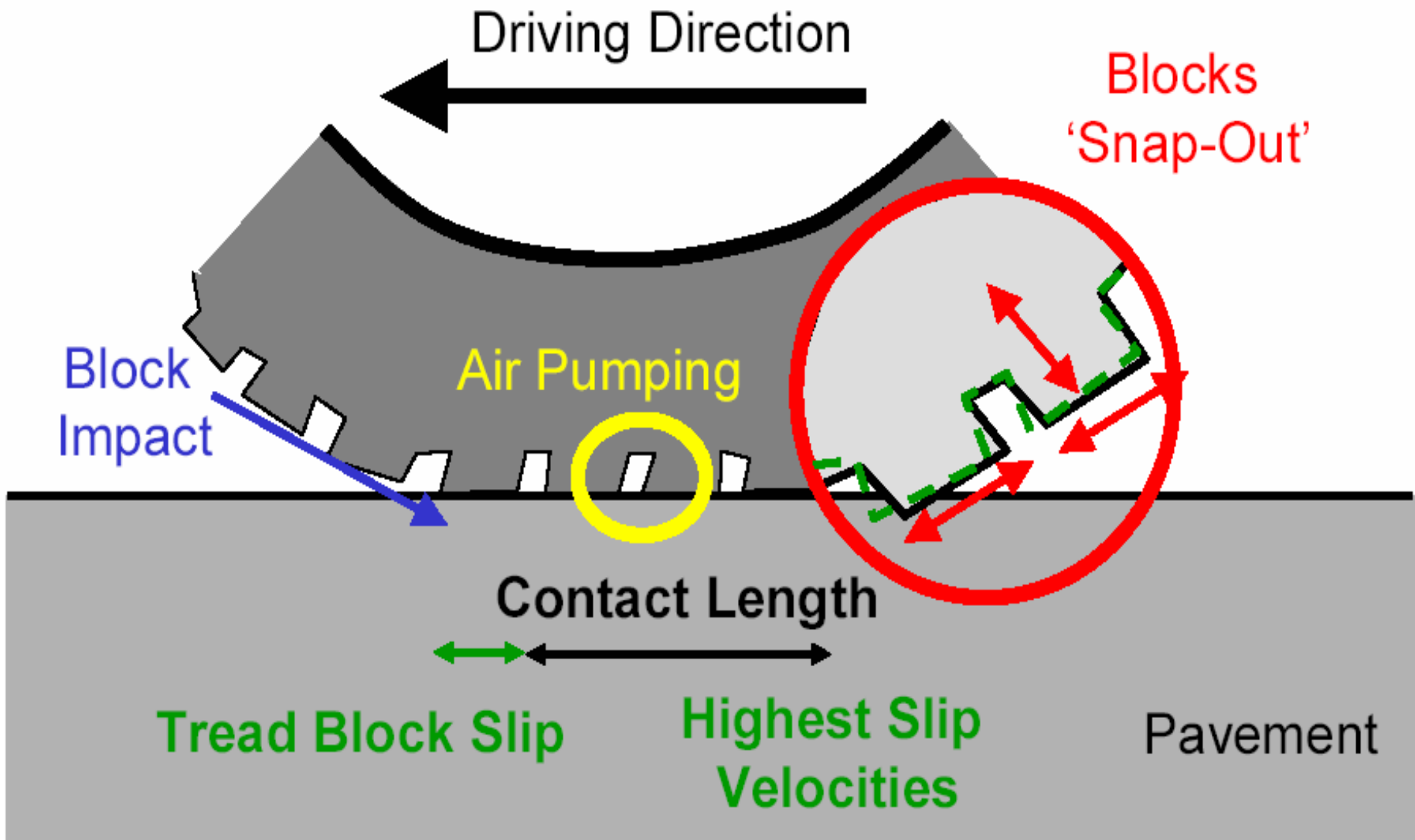
- Sources of traffic noise
- Tire-pavement noise mechanisms
- Methods for reducing noise on HMA
- Ongoing research

Sources of Traffic Noise

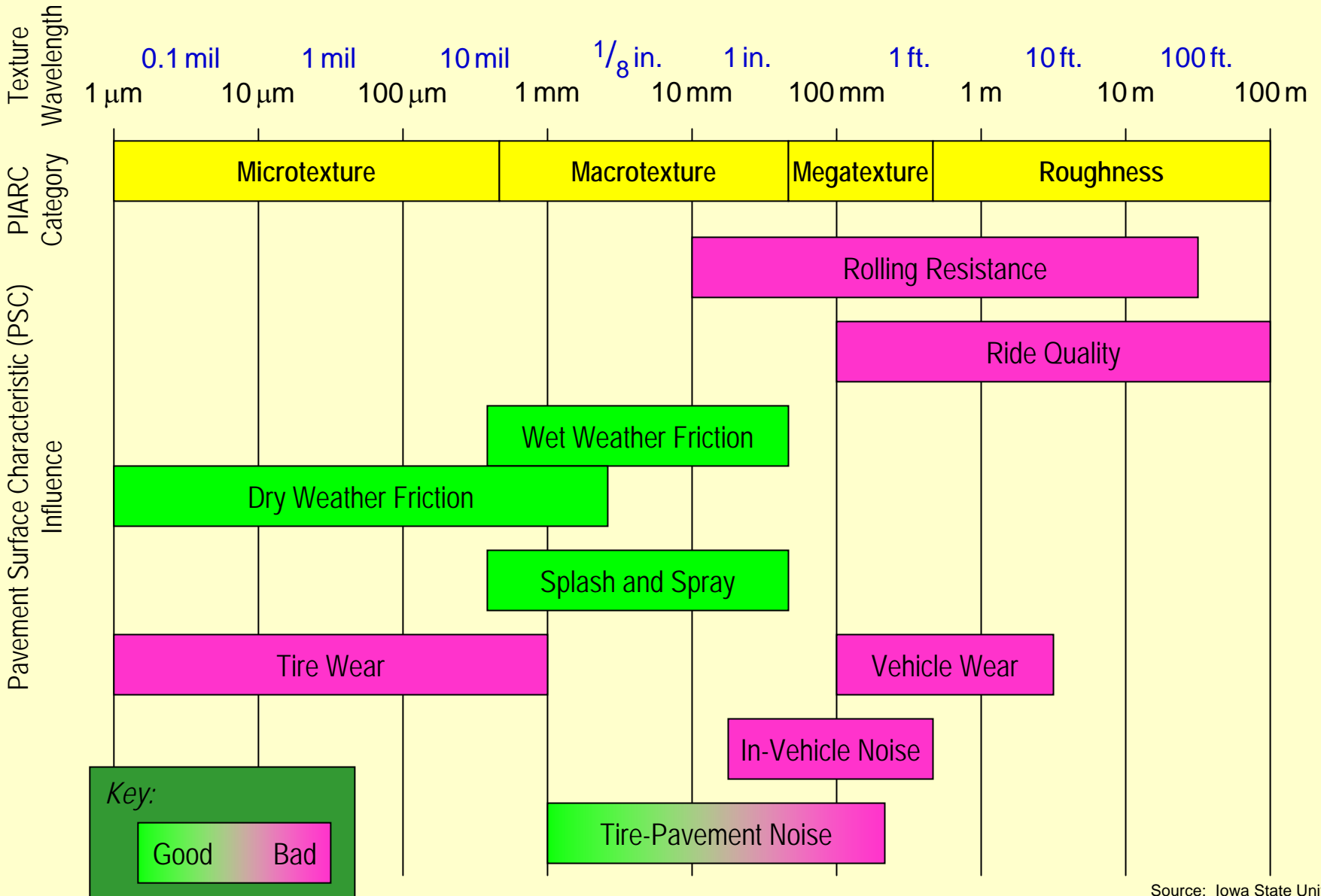
Noise Source Distribution of a 74dB vehicle in drive-by test



Components of Tire-Pavement Noise



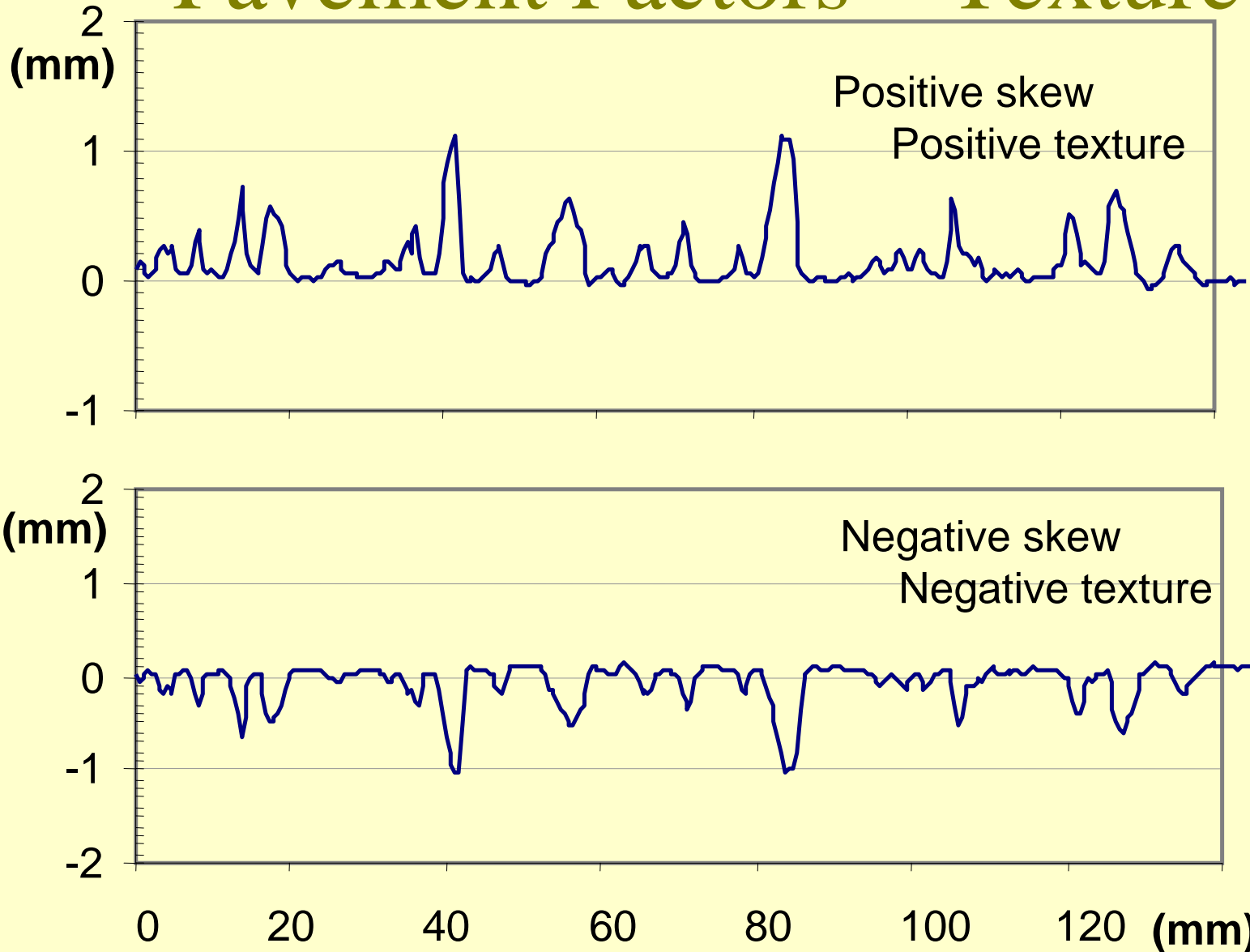
Texture-Noise Relationship



Pavement Factors

| No. | Parameter | Degree of influence |
|-----|---------------------|---------------------------|
| 1 | Macrotexture | Very high |
| 2 | Megatexture | High |
| 3 | Microtexture | Low - moderate |
| 4 | Unevenness | Minor |
| 5 | Porosity | Very high |
| 6 | Thickness of layer | High, for porous surfaces |
| 7 | Adhesion (normal) | Low/moderate |
| 8 | Friction (tangent.) | See microtexture |
| 9 | Stiffness | Uncertain, moderate (?) |

Pavement Factors – Texture



Pavement Technologies

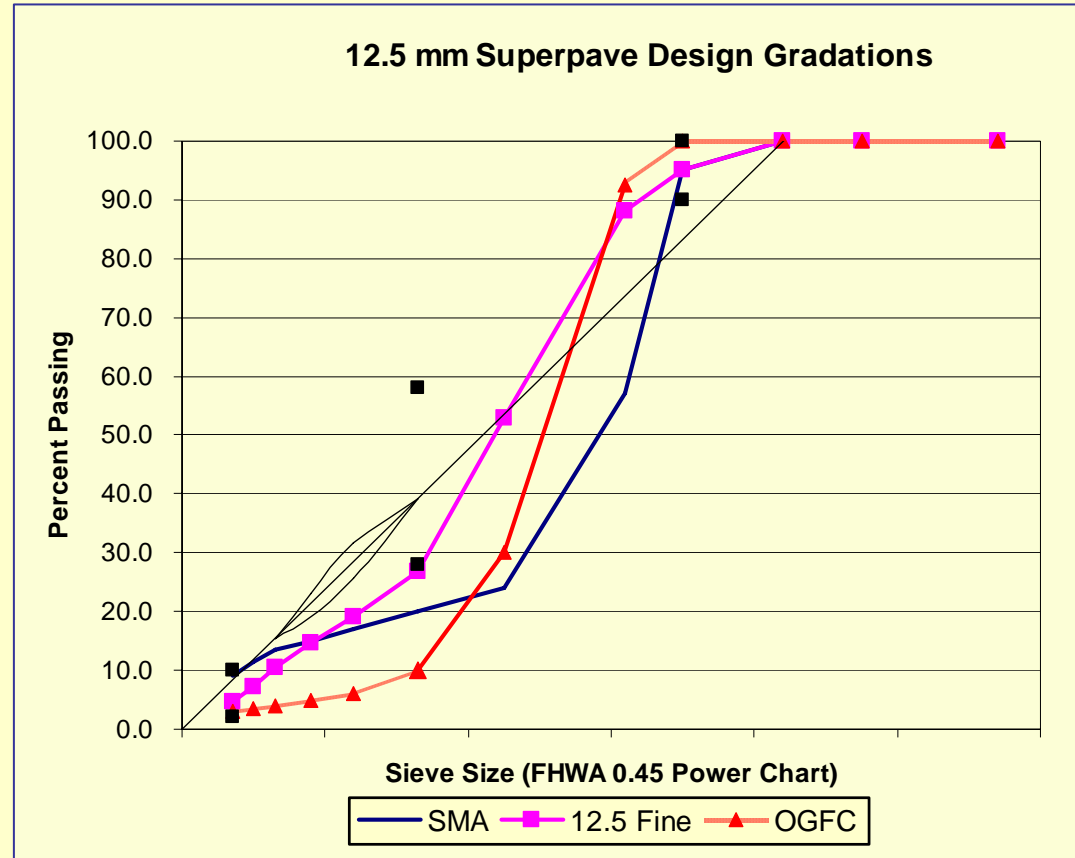
- Asphalt technologies
 - Fine Superpave mixes
 - Stone Matrix Asphalt (SMA)
 - Porous Friction Course



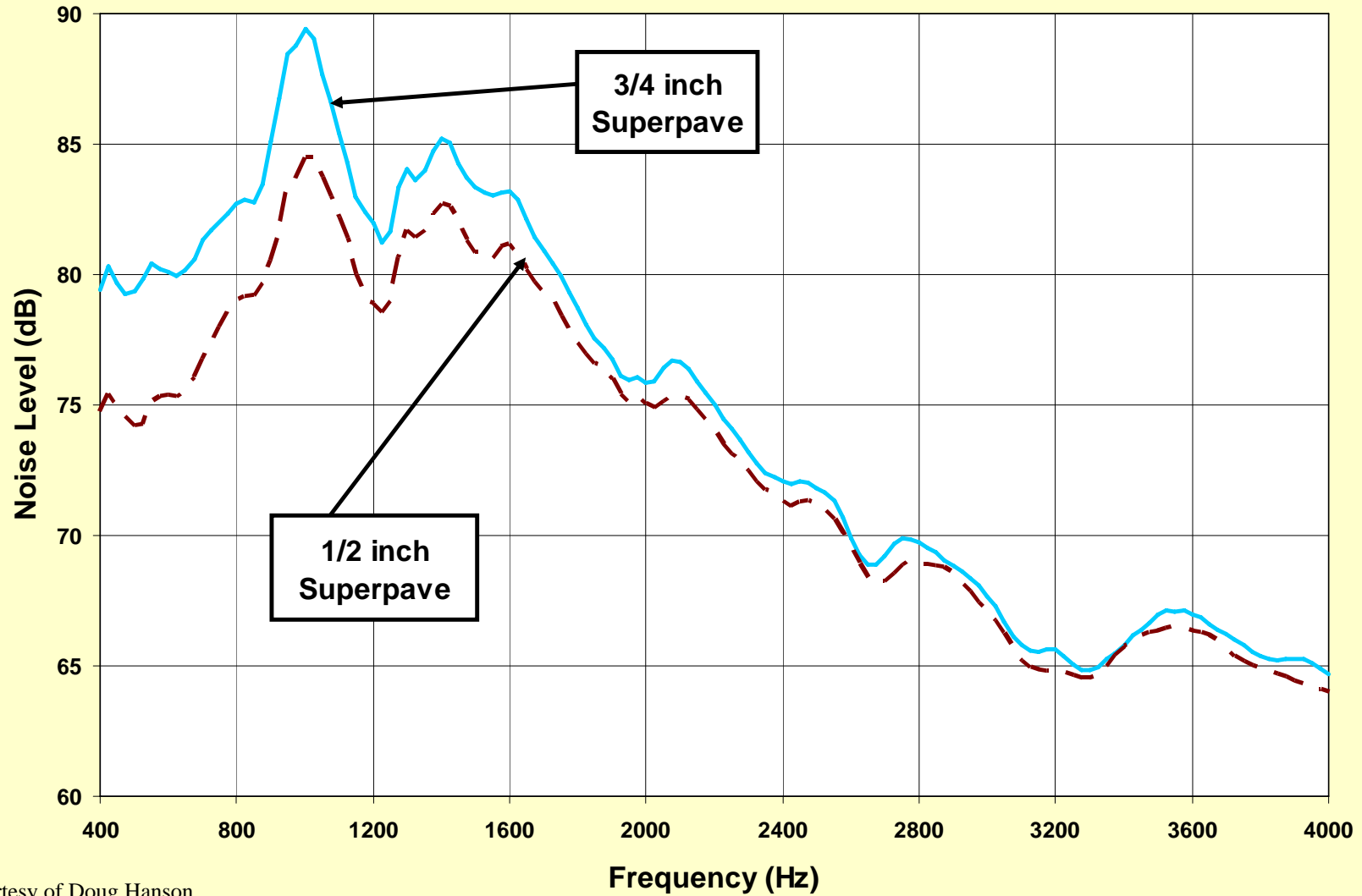
Fine Superpave Mixes

Fine Superpave Mixes

- Small aggregate size
- Fine gradation
- Dense graded
- Pooled fund



Noise Level vs. Aggregate Size

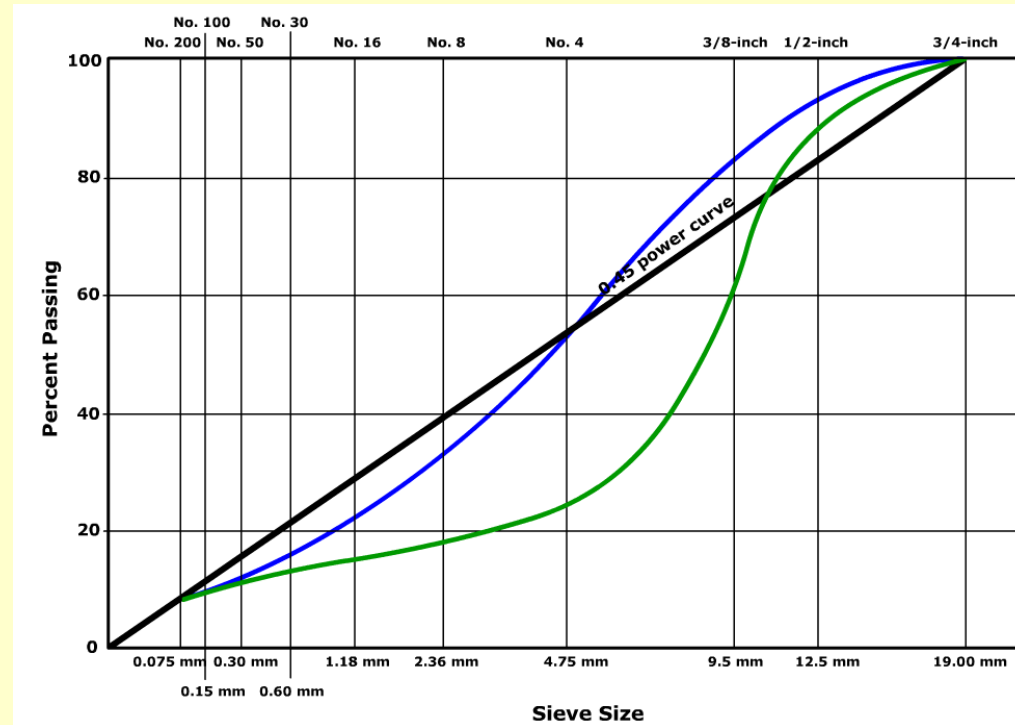


A close-up photograph of Stone Matrix Asphalt (SMA) pavement. The surface is composed of dark, angular aggregate particles of various sizes, densely packed together. A black circular object with the word "OLYMPUS" printed in white is placed on the right side of the image to provide a scale reference. The text "Stone Matrix Asphalt" is overlaid in a large, white, serif font across the center of the image.

Stone Matrix Asphalt

Stone Matrix Asphalt

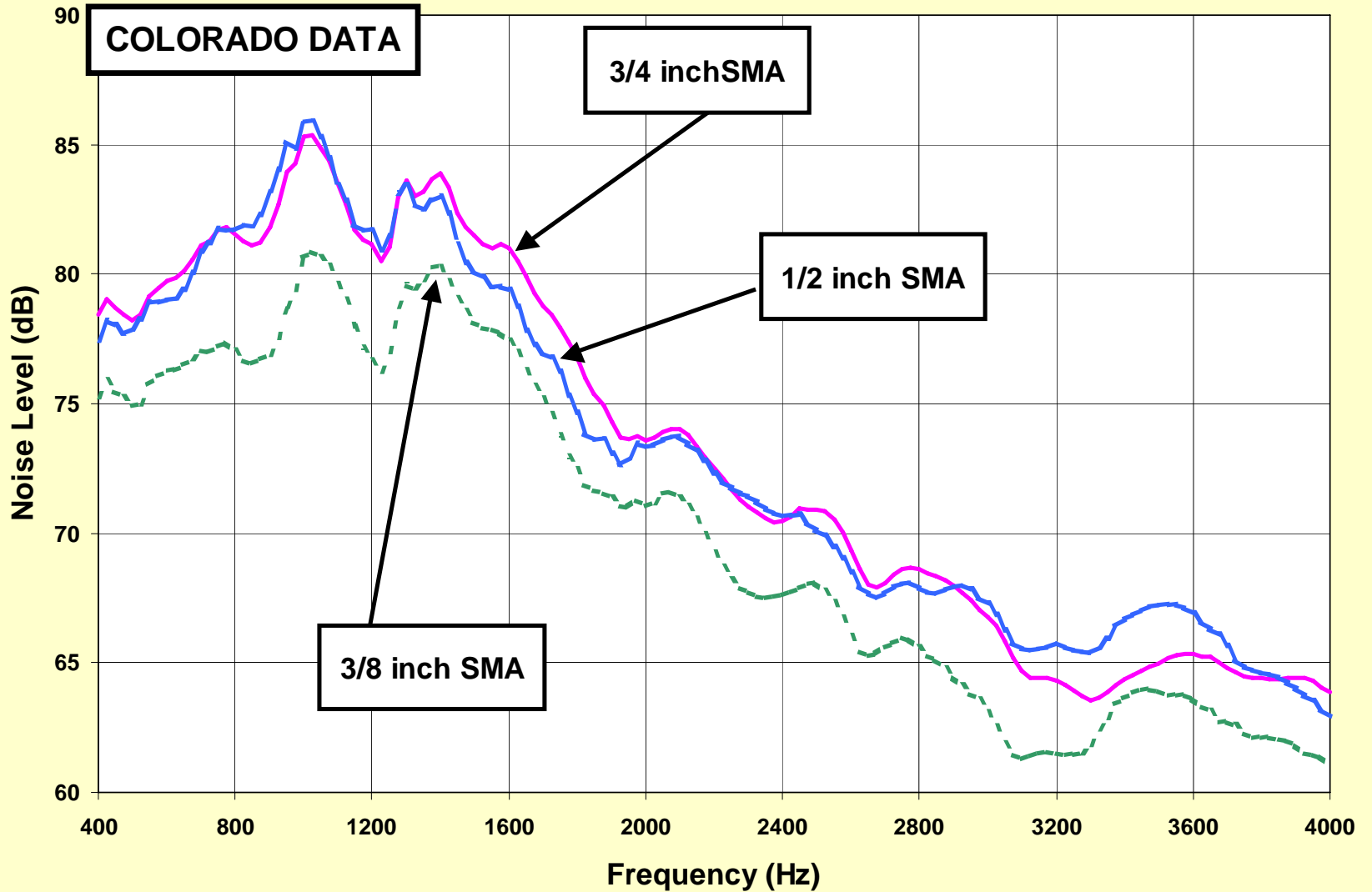
- Small aggregate size
- Gap-graded aggregate (usually from coarse aggregate)
- Manufactured sands and mineral filler
- Asphalt binder typically modified



Stone Matrix Asphalt



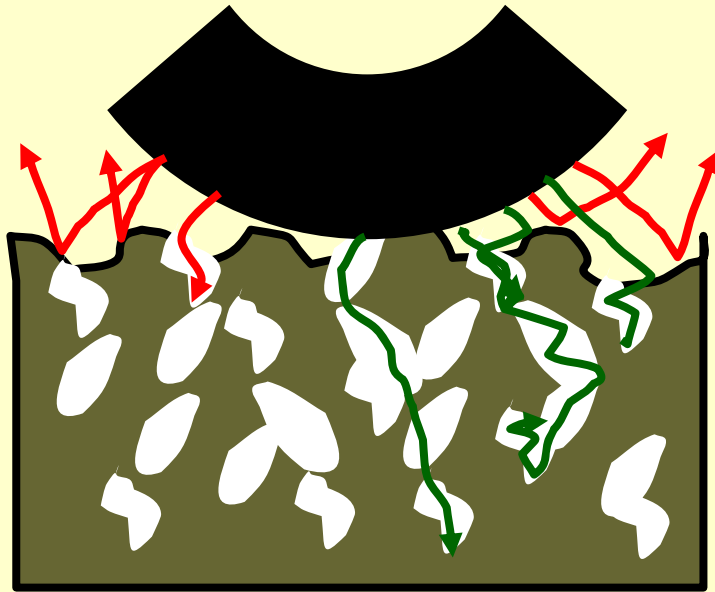
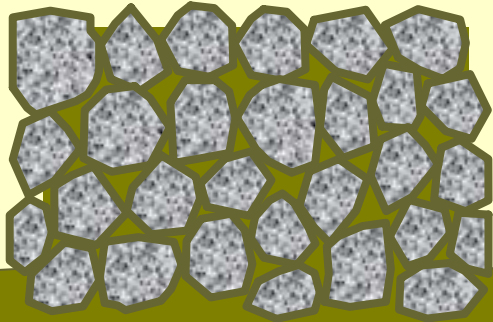
Noise Level vs. Aggregate Size





Porous Friction Course

Porous Friction Course



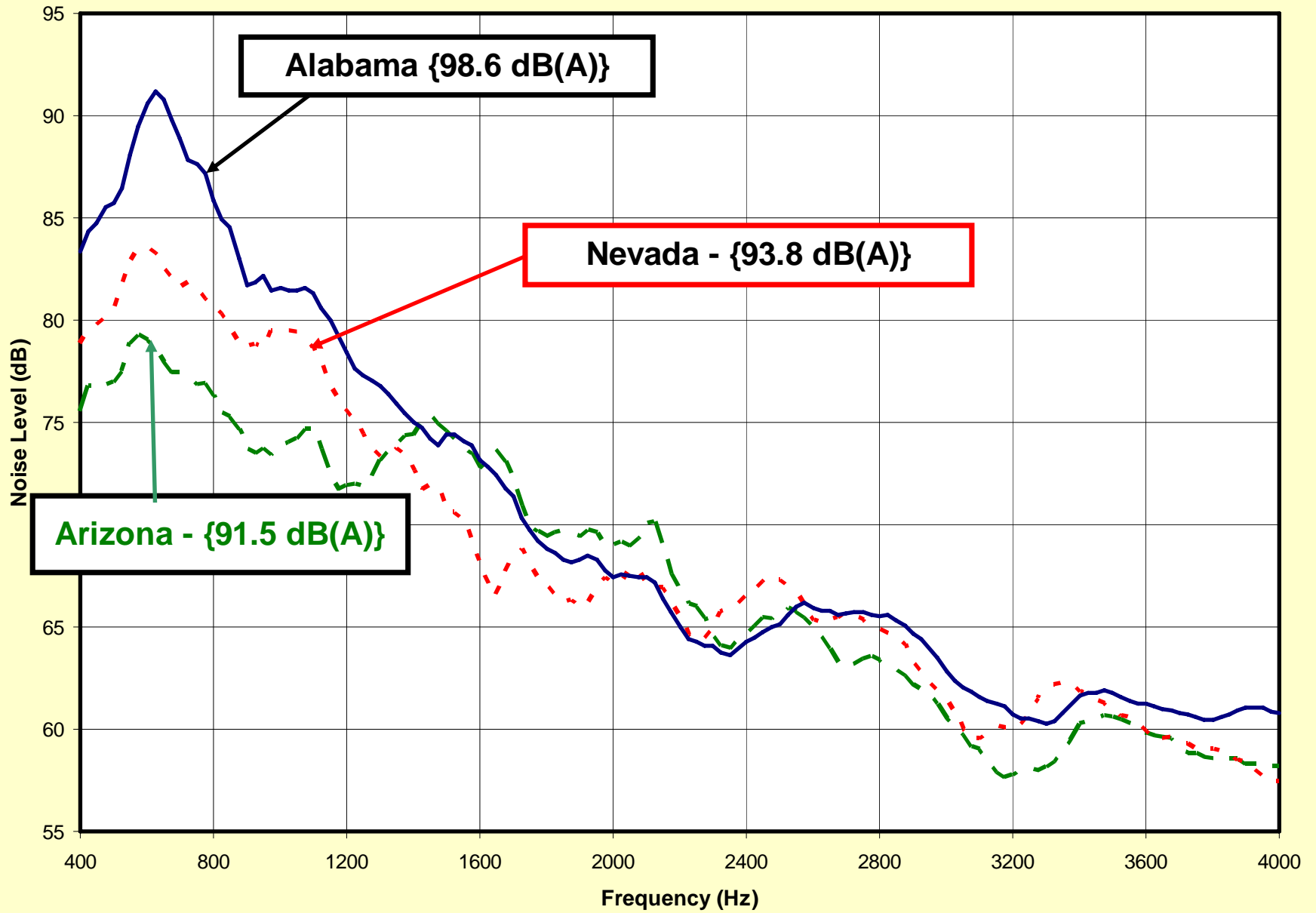
- Small aggregate size
- Open-graded aggregate
 - High volume of voids
≥ 20% air voids, in place
- Thick asphalt binder coating
- Array of tortuous pores
- Dissipates energy through friction
- Reduce surface area and slip-stick or slap
- Reduces horn effect
- Modified binders may increase elasticity

Porous Friction Course

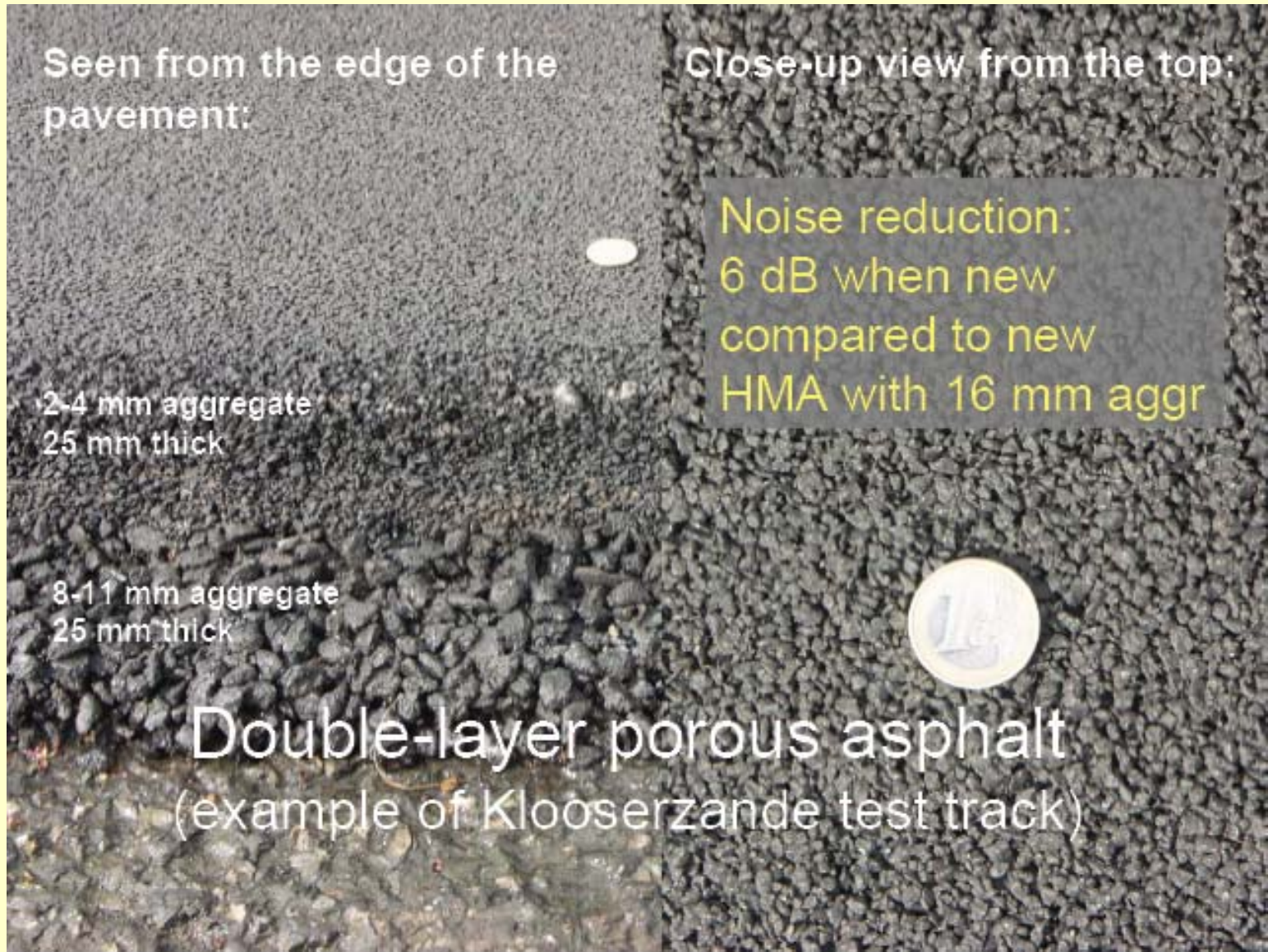


OGFC GRADATIONS

| Gradation | Arizona¹ | Nevada¹ | AL 1 – 7² |
|-------------------------|----------------------------|---------------------------|-----------------------------|
| Nominal Max Size | 4.75 mm | 9.5 mm | 12.5 mm |
| ¾ inch | - | - | 100 |
| ½ inch | - | 100 | 89 |
| 3/8 inch | 100 | 95 | 56 |
| No. 4 | 38 | 45 | 14 |
| No. 8 | 6 | - | 9 |
| No. 16 | - | 11 | - |
| No. 200 | 1.2 | 2 | 3.2 |
| Fineness Modulus | 5.42 | 5.00 | 6.14 |
| Air Voids | - | - | 17 % |
| Noise Level | 91.5 | 93.8 | 98.6 |

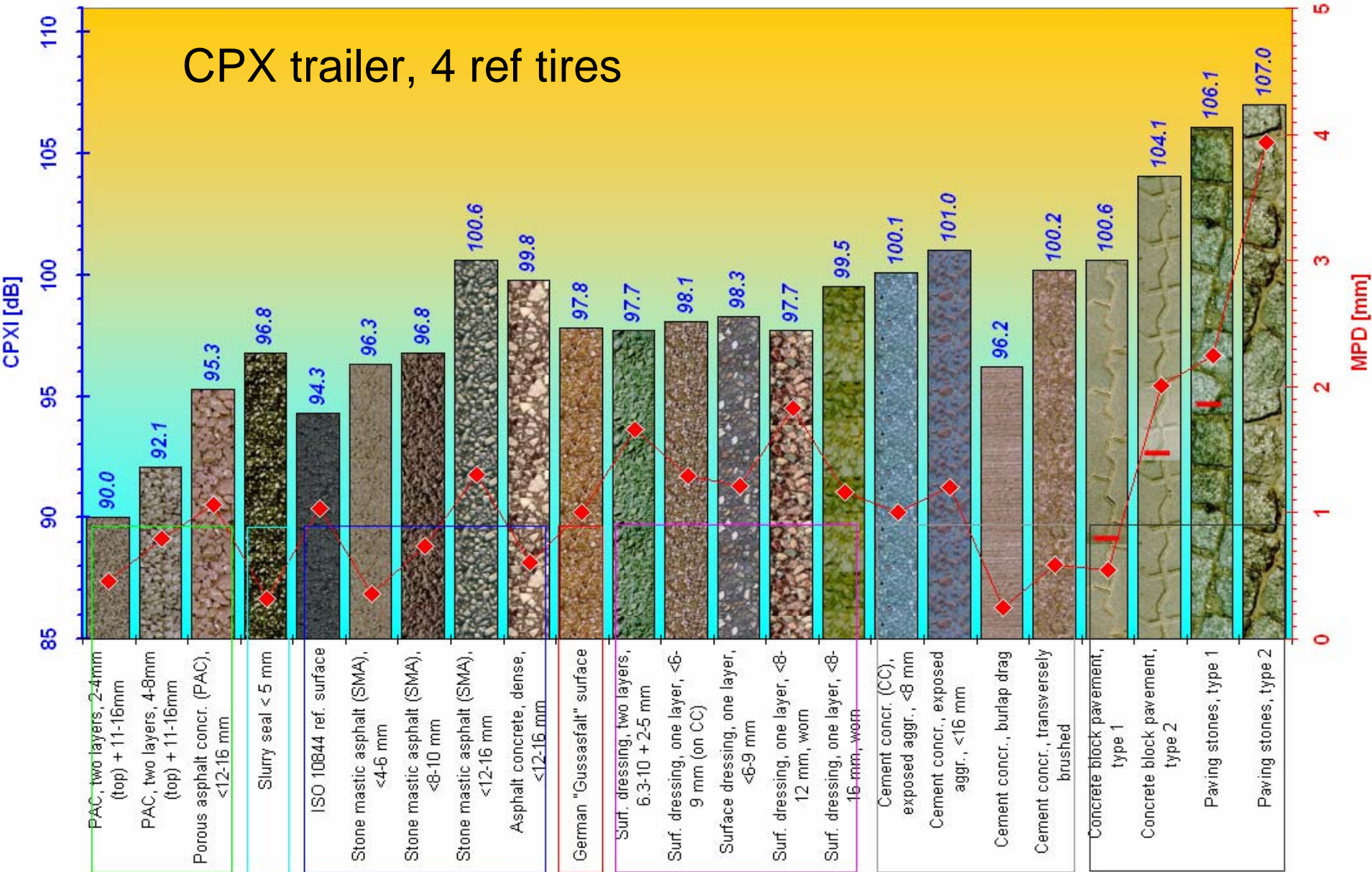


Porous Friction Course



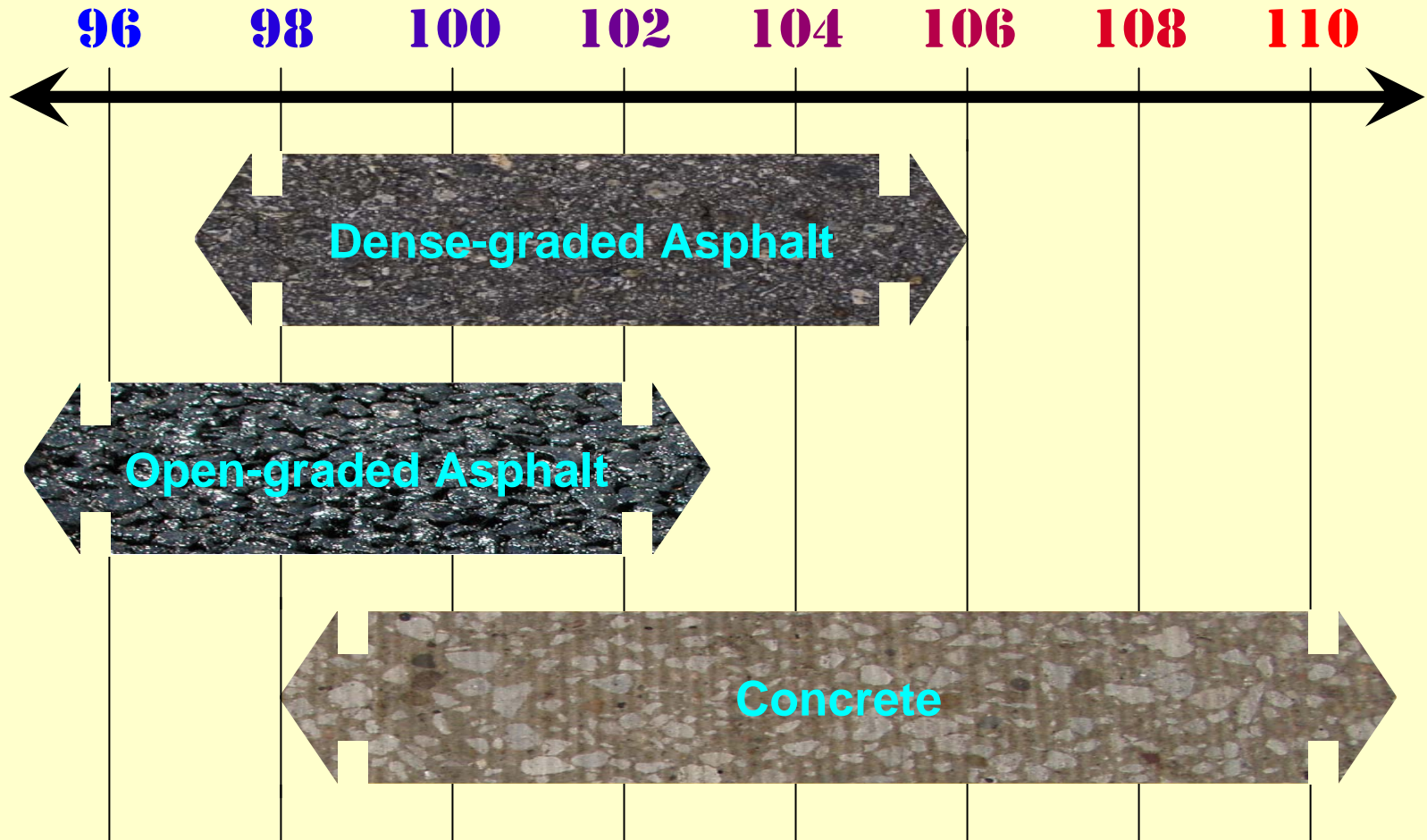
Pavement Performance

CPX trailer, 4 ref tires



Pavement Performance

Typical Sound Intensity (dBA)



Ongoing Research

- National Center for Asphalt Technology:
Evaluation of Low Noise Pavements
- Poroelastic Road Surface (PERS)

NCAT Quiet Pavement Development

- Development and evaluate quiet pavement technology
 - Double layer porous
 - Thin, gap-graded asphalt layers

AU 4-C2 Sections

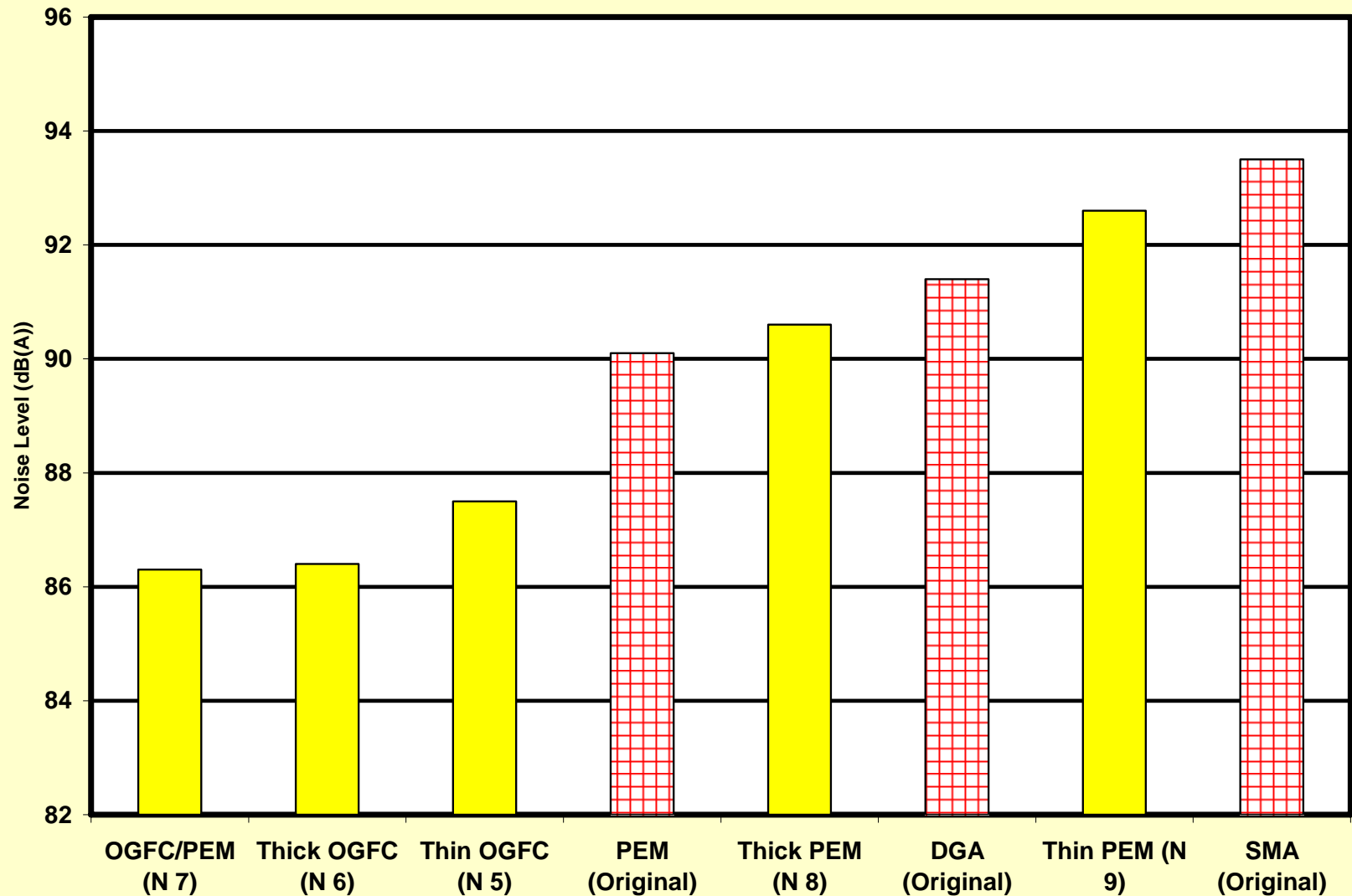
North Tangent

| | N 5 | N 6 | N 7 | N 8 | N 9 |
|----------------------|---------|---------|---------|-----|-------|
| Layer 1 (1 ¼ inches) | AZ OGFC | AZ OGFC | AZ OGFC | PEM | PEM |
| Layer 2 (1 ¼ inches) | Track | AZ OGFC | PEM | PEM | Track |

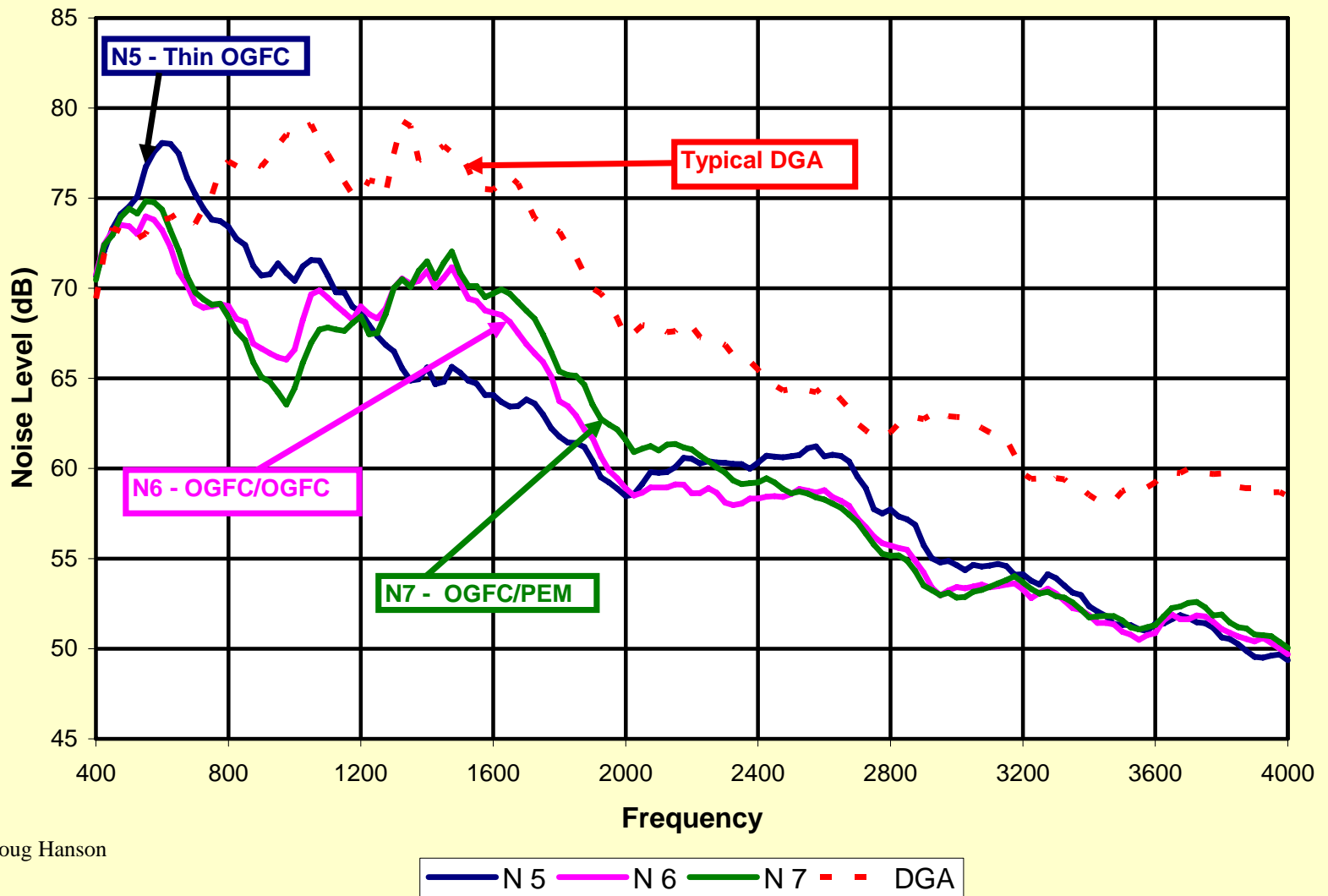
South Tangent

| | S 4 | S 5 | S 6 | S 7 | S 8 |
|---------------------|------------|----------|---------|----------|---------|
| Layer 1 (1¼ inches) | < 4.75 SMA | 4.75 SMA | 9.5 SMA | 4.75 DGA | 9.5 DGA |
| Layer 2 | Track | | | | |

AU 4-C2 Sections



AU 4-C2 Sections

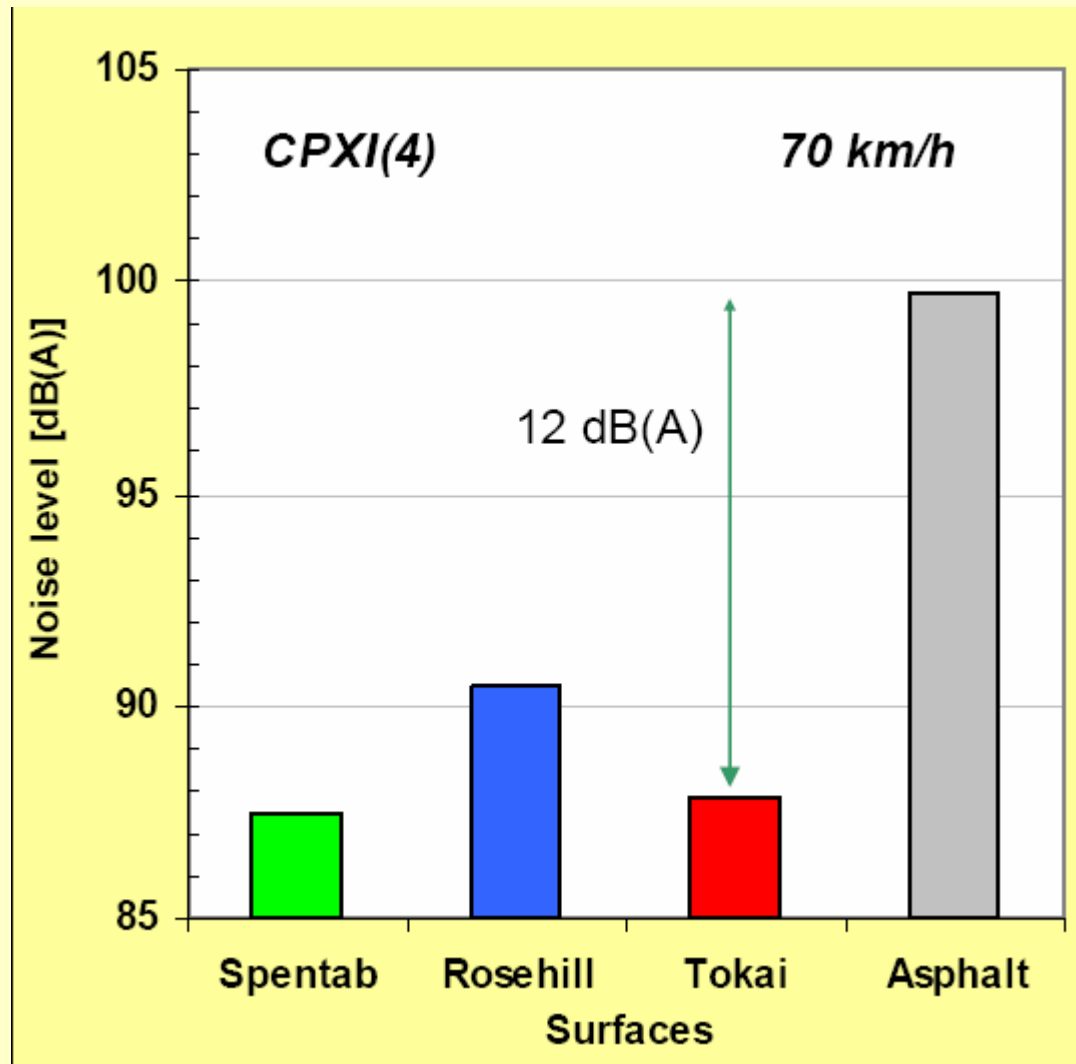


Courtesy of Doug Hanson

Poroelastic Road Surface (PERS)



Poroelastic Road Surface (PERS)



Poroelastic Road Surface (PERS)



Thank You

Mark Swanlund

Office of Pavement Technology

