National Center for Asphalt Technology
NCAT
AUBURN UNIVERSITY

Tire/Pavement Noise

Nature of highway noise

Tire / pavement

- Generally the primary source at highway speeds (greater than 35 mph)
  - Level is dependent on vehicle type, vehicle speed and tire type
- Other sources include
  - Vehicle – engine, exhaust, etc.
  - Aerodynamic sources

Nature of highway noise

Sound absorption of pavement

- Greater absorption – less sound reflected off road and into communities
- Some quiet pavements absorb high frequency sound

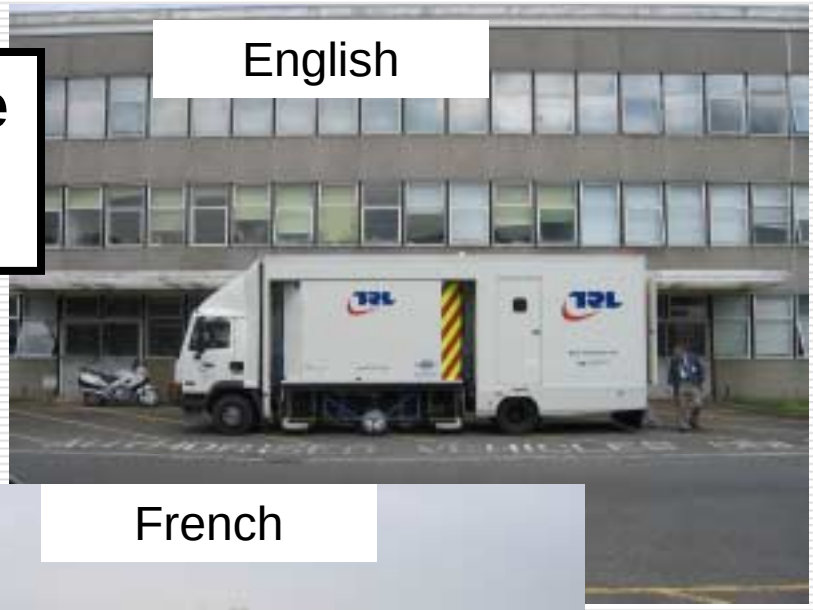
Measurement of Traffic Noise

- Source measurement – measures the effect of quiet pavement on the tire/pavement interaction at the source
- Wayside measurements – measures the effects of quiet pavements on communities

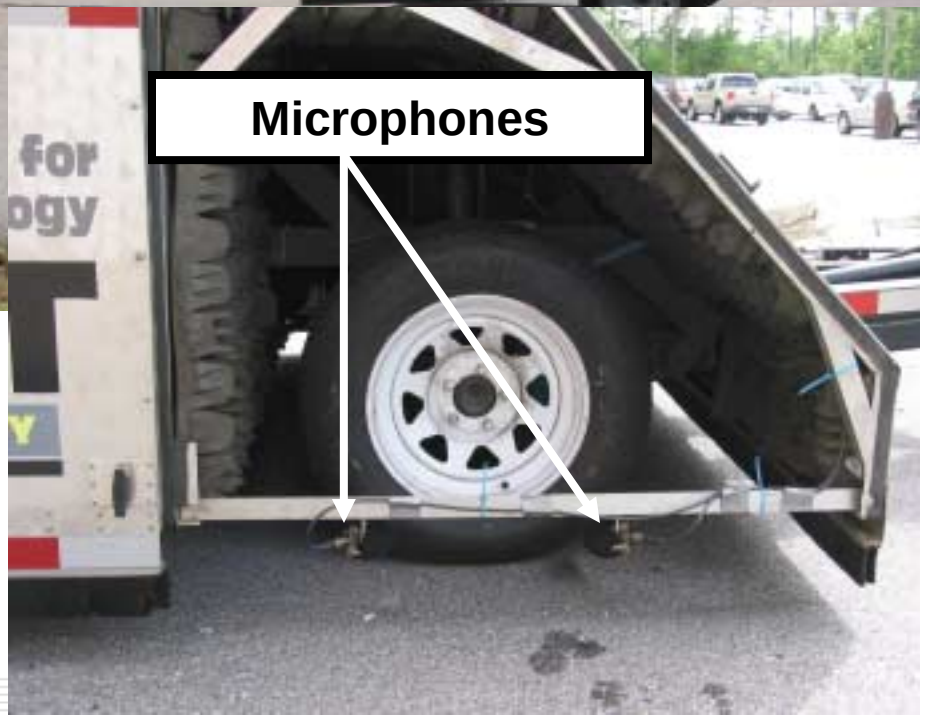
Source measurement

Common Procedure in Europe

Standard is ISO 11819-2



Meets ISO 11819-2

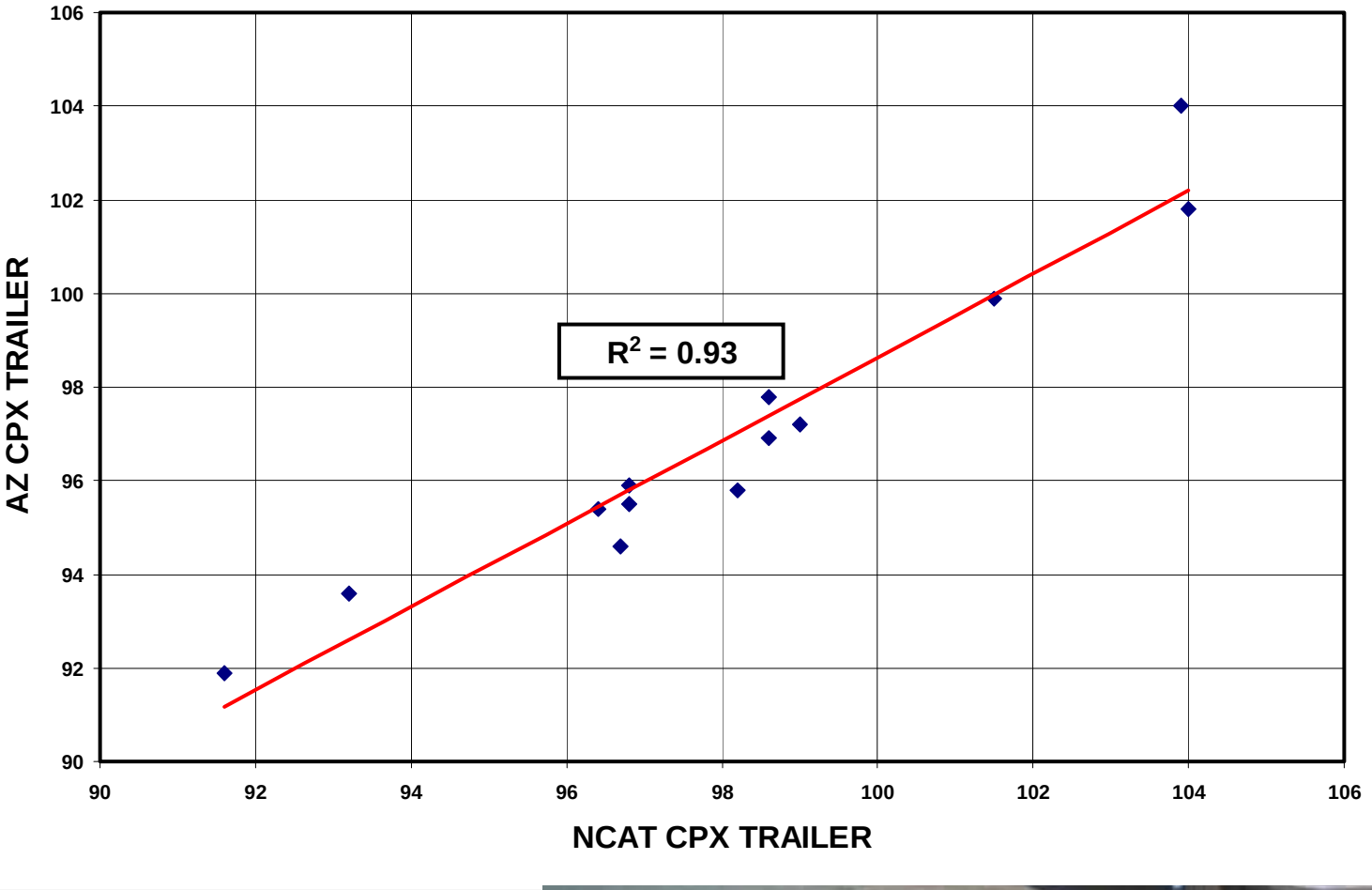


NCAT Close Proximity Noise Trailer

NCAT Trailer

- Advantages
  - Isolates tire/pavement noise
    - Great for comparing road surfaces
  - Efficient and inexpensive
  - Measures the road properties along extended length of road surface
- Disadvantages
  - Isolates tire/pavement noise
    - Cannot determine the quiet pavement benefits in communities – correlation with wayside measurements is being investigated
    - Single vehicle/tire type is represented

NCAT CPX Trailer



AZ CPX Trailer

Wayside measurements

- **Statistical pass-by method**
  - Based on measuring the noise level from a minimum of 180 single-vehicle passbys
  - Can compare pavements at different locations
  - Microphones generally set at 50 ft from roadway
- **Controlled pass-by**
  - Same as statistical pass-by but with limited number of vehicles
- **Time-averaged method**
  - Noise-level is measured continuously over a time period
  - Traffic counts & metrological data is needed

Wayside measurements

- **Advantages**
  - Results account for mix of traffic
  - Results account for noise from all sources (tire, engine, exhaust)
  - Helps to determine enviromental effects & noise abatement policy

- **Disadvantages**
  - Time consuming and costly
  - Examines road properties at only one location
  - Strict measurement conditions (site geometry, traffic density, etc.)

Knowledge Gap

- Can the source measurements be correlated to the wayside measurements?
- Two preliminary studies have been done – they showed it could be done and the difference is about 23 dB(A)
- Thus, if the trailer measures 95 dB(A) – at 25 feet from the source the noise level would be 72 dB(A)
- More work is needed!!

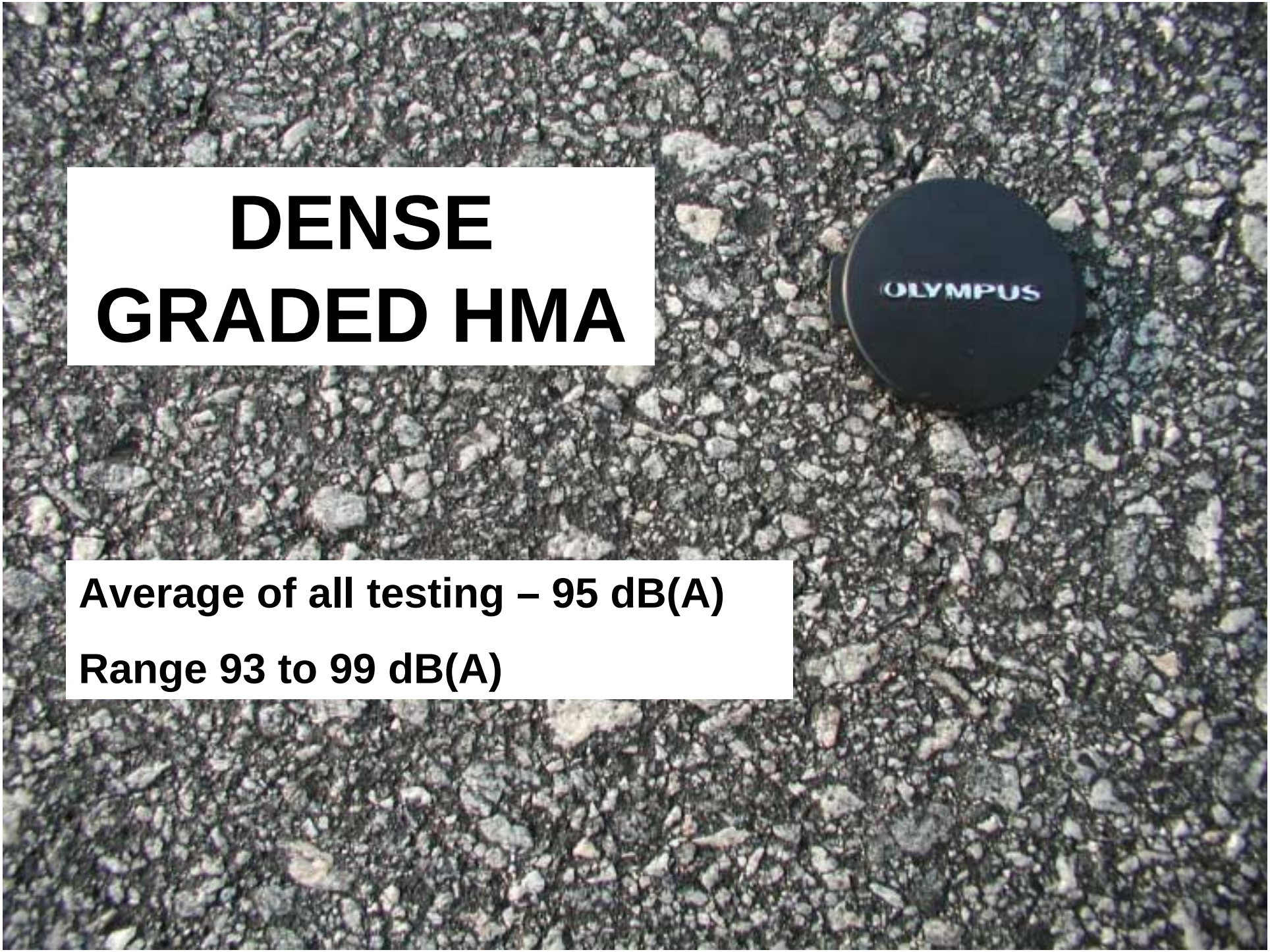
Noise Characteristics of Pavement Surfaces

Pavements tested

- Locations
  - NCAT test track, Michigan, Alabama, New Jersey, Maryland, Colorado, Nevada, California, Arizona, Texas, Florida, Virginia
- Numbers of surfaces tested
  - Total – 244 surfaces
  - HMA – 201 surfaces
  - PCCP – 43 surfaces
- Currently conducting testing in –
  - Minnesota and Colorado

PCCP – NCAT Testing
(44 surfaces)

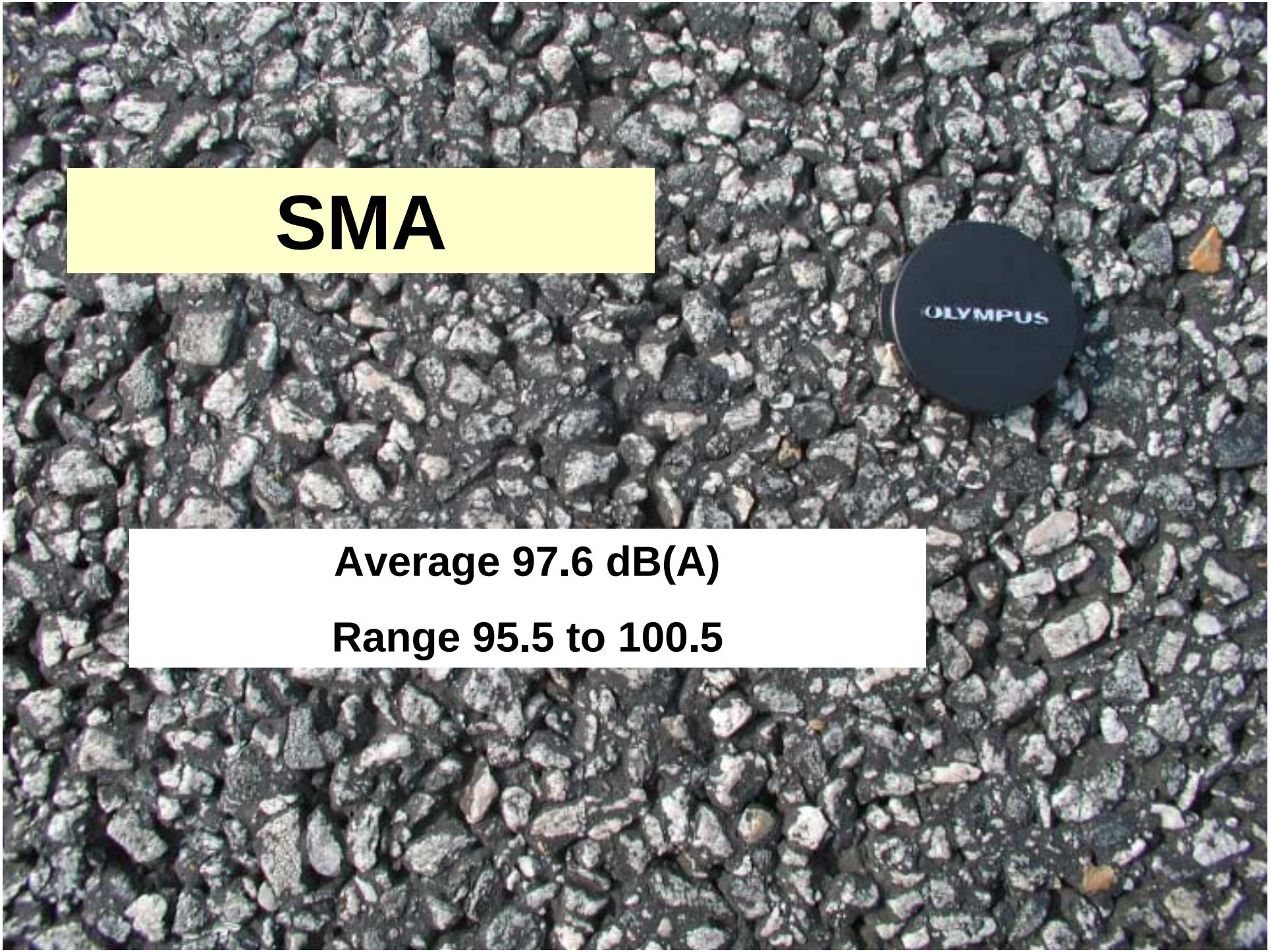
- **Transverse Tined**
  - Average - 103.6 dB(A)
  - Range - 100.5 to 106.5 dB(A)
- **Longitudinally Ground**
  - Average - 99.6 dB(A)
  - Range - 98.1 to 103.6 dB(A)
- **Diamond Ground**
  - Average - 98.9 dB(A)
  - Range - 97.7 to 101.0 dB(A)



DENSE GRADED HMA

Average of all testing – 95 dB(A)

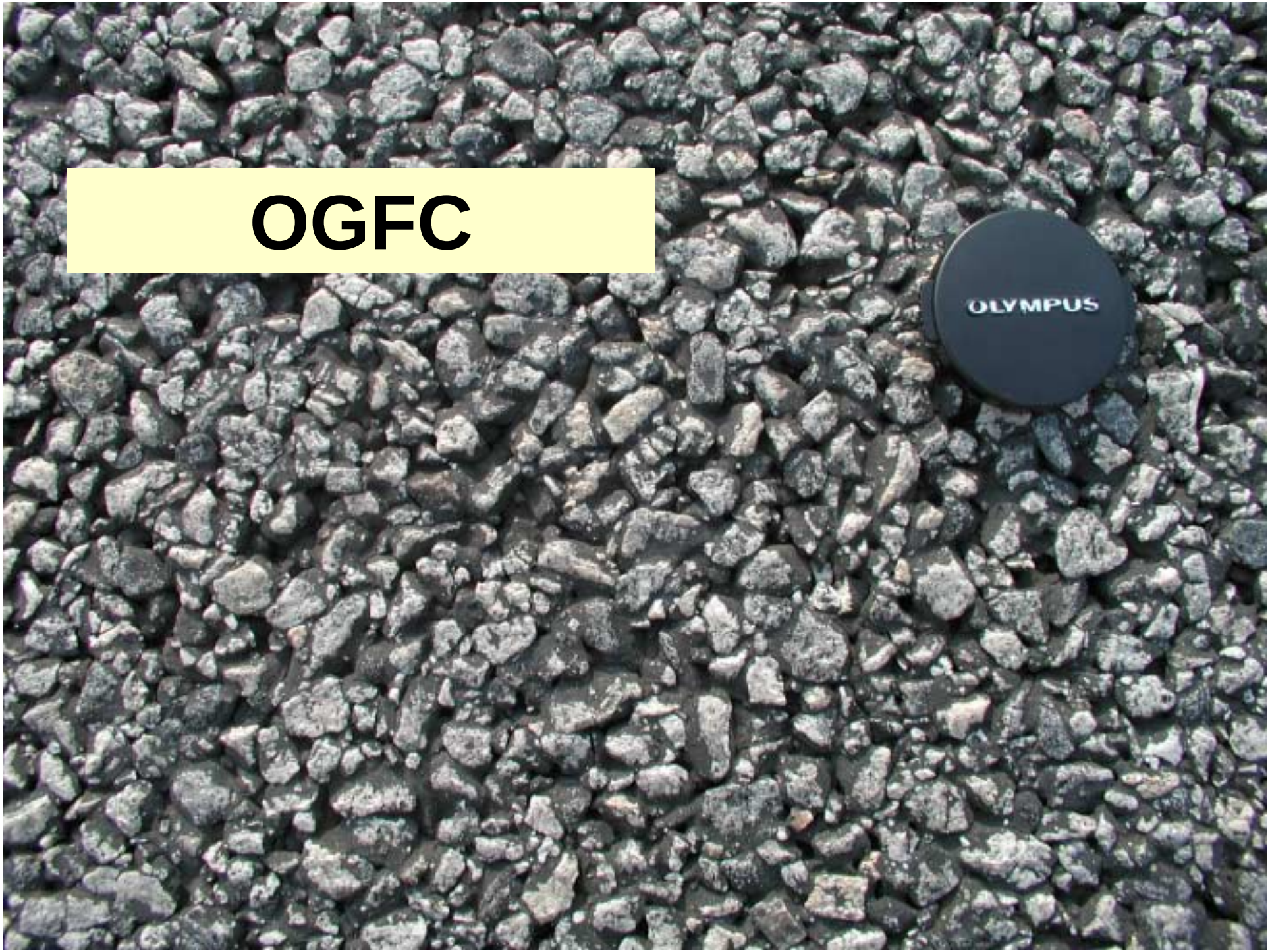
Range 93 to 99 dB(A)


SMA
OLYMPUS
Average 97.6 dB(A)
Range 95.5 to 100.5

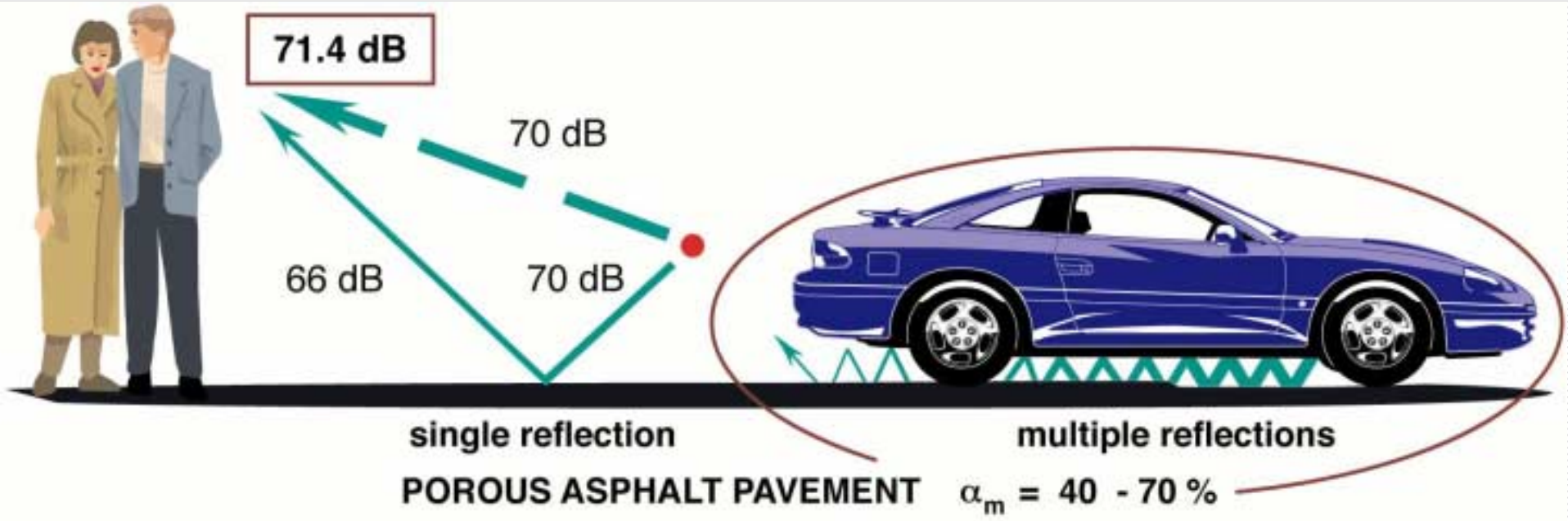
SMA

Route	State	Noise Level	Mix	Date Placed
MD 50	MD	95.5 dB(A)	9.5 mm	2002
I – 270	MD	97.7 dB(A)	12.5 mm	2003
I - 495	MD	98.9 dB(A)	12.5 mm	2003
I - 83	MD	99.0 dB(A)	19 mm	1994
US 50	CO	96.2 dB(A)	12.5 mm	2002
I – 70 W	CO	96.3 dB(A)	19 mm	2003
I – 225 N	CO	96.9 dB(A)	19 mm	2002
US 1	NJ	100.5 dB(A)	19 mm	-

The smaller the nominal maximum size of the aggregate the lower the noise level.


OGFC
OLYMPUS

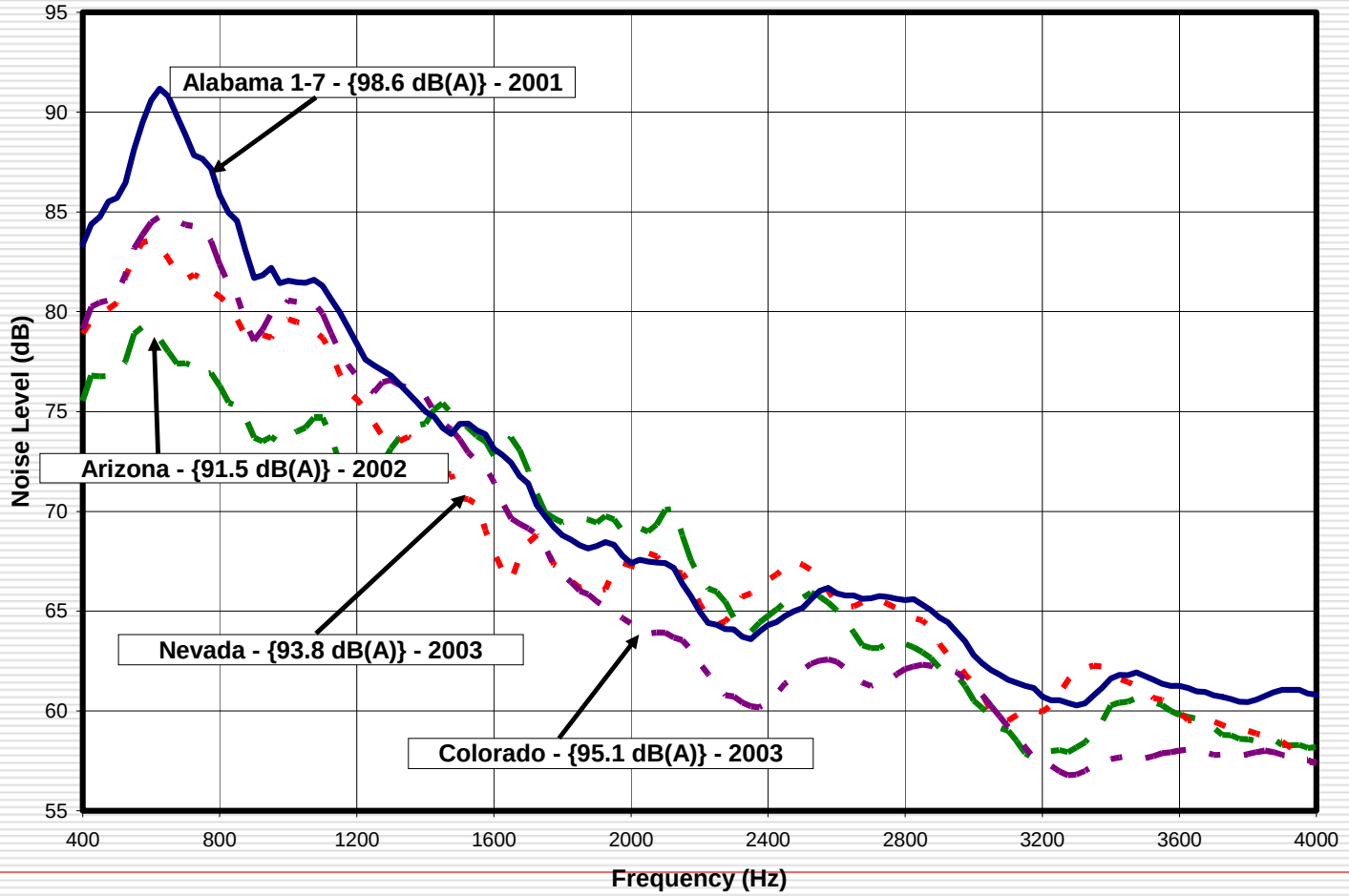
The OGFC Absorbs Part of the Sound Energy



Open Graded Mixes

- Alabama OFGC
  - Average: 97.2
  - Range: 95 to 98
- Nevada – No rubber
  - 1 yr – 93.7, 6 yr – 93.6, 8 yr – 93.8
  - 11 yr – 98.8
- Arizona – Rubber modified
  - Average: 92.0

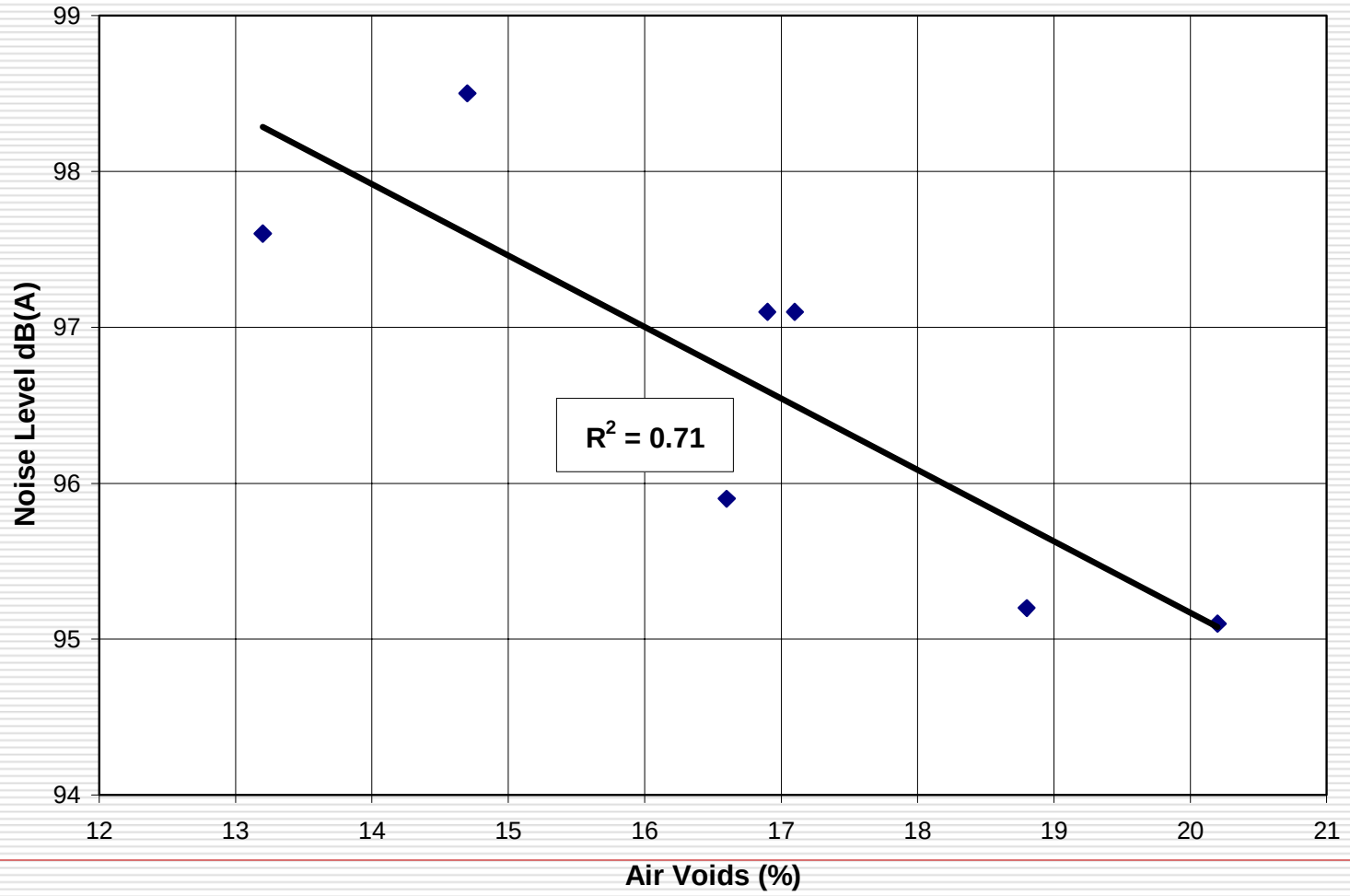
OGFC Comparisons



GRADATIONS

Gradation	Arizona[1]	Nevada[1]	Colorado[2]	AL 1 – 7[2]
¾ inch	-	-	100	100
½ inch	-	100	98	89
3/8 inch	100	95	64	56
No. 4	38	45	11	14
No. 8	6	-	8	9
No. 16	-	11	6	-
No. 200	1.2	2	3.3	3.2
Fineness Modulus	5.42	5.00	6.00	6.14
Air Voids	-	-	21 %	17 %
Noise Level	91.5	93.8	95.1	98.6

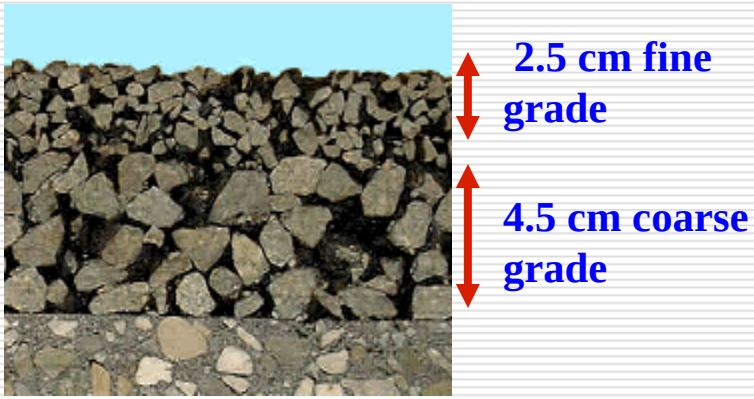
Effect of Air Voids on Noise (OGFC)



QUIET PAVEMENT - Europe

Two Layer Porous Asphalt

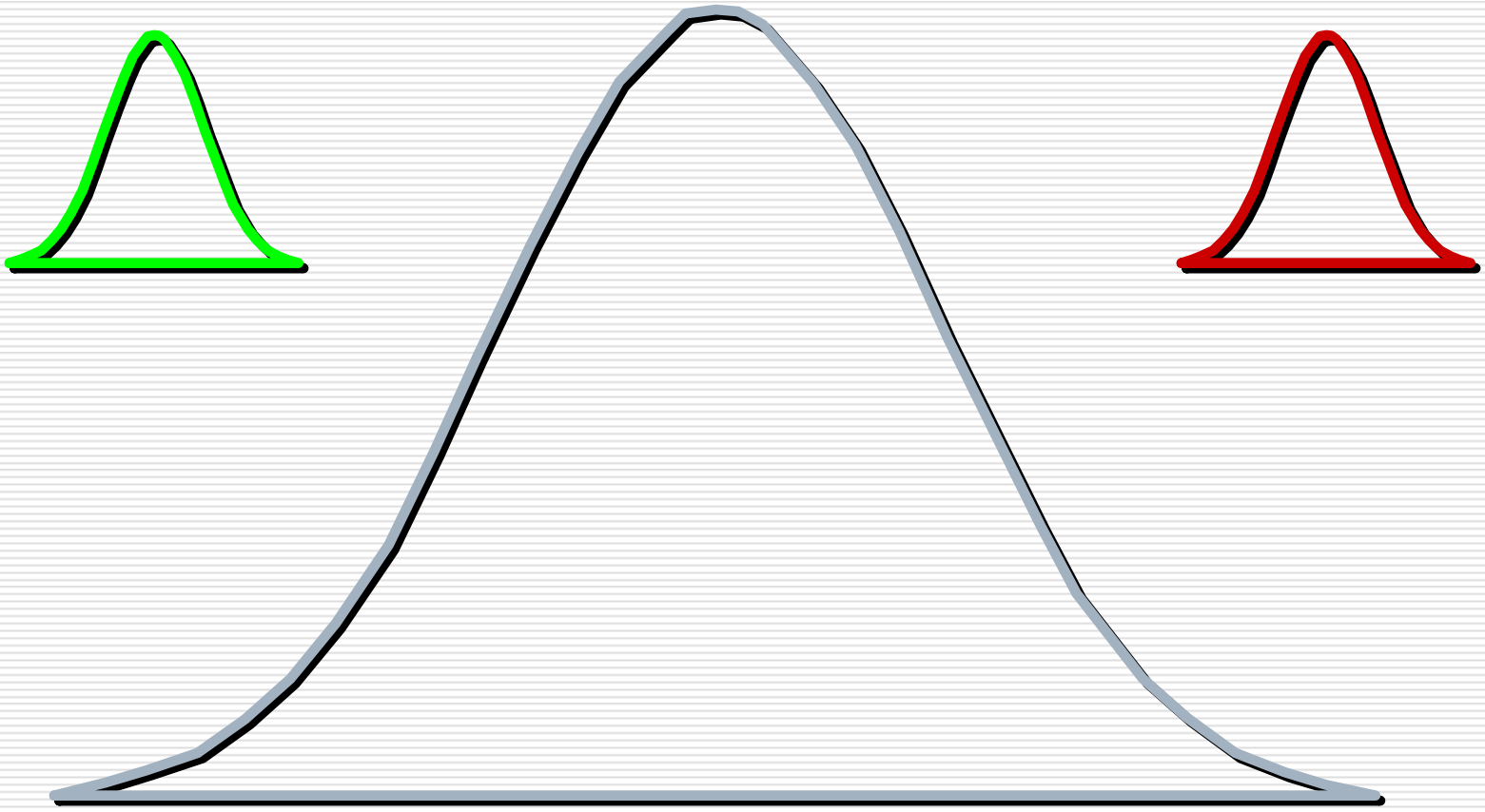
- 2.5 cm fine grade (top) 2/6 or 4/8 mm aggregate
- 4/5 cm course grade 11/16 mm aggregate (lower layer)
- 8-9 dBA quieter than conventional mixes
- 4 dBA quieter than single layer (high speed)
- Higher cost than single layer mix (25-35 %)



Conclusions

- OGFC mixes reduce the high frequency noise
- The gradation of an OGFC affects the low frequency noise – the coarser the mix the higher the low frequency noise
- Based on European testing – thickness may also reduce low frequency noise

Variability on the Road

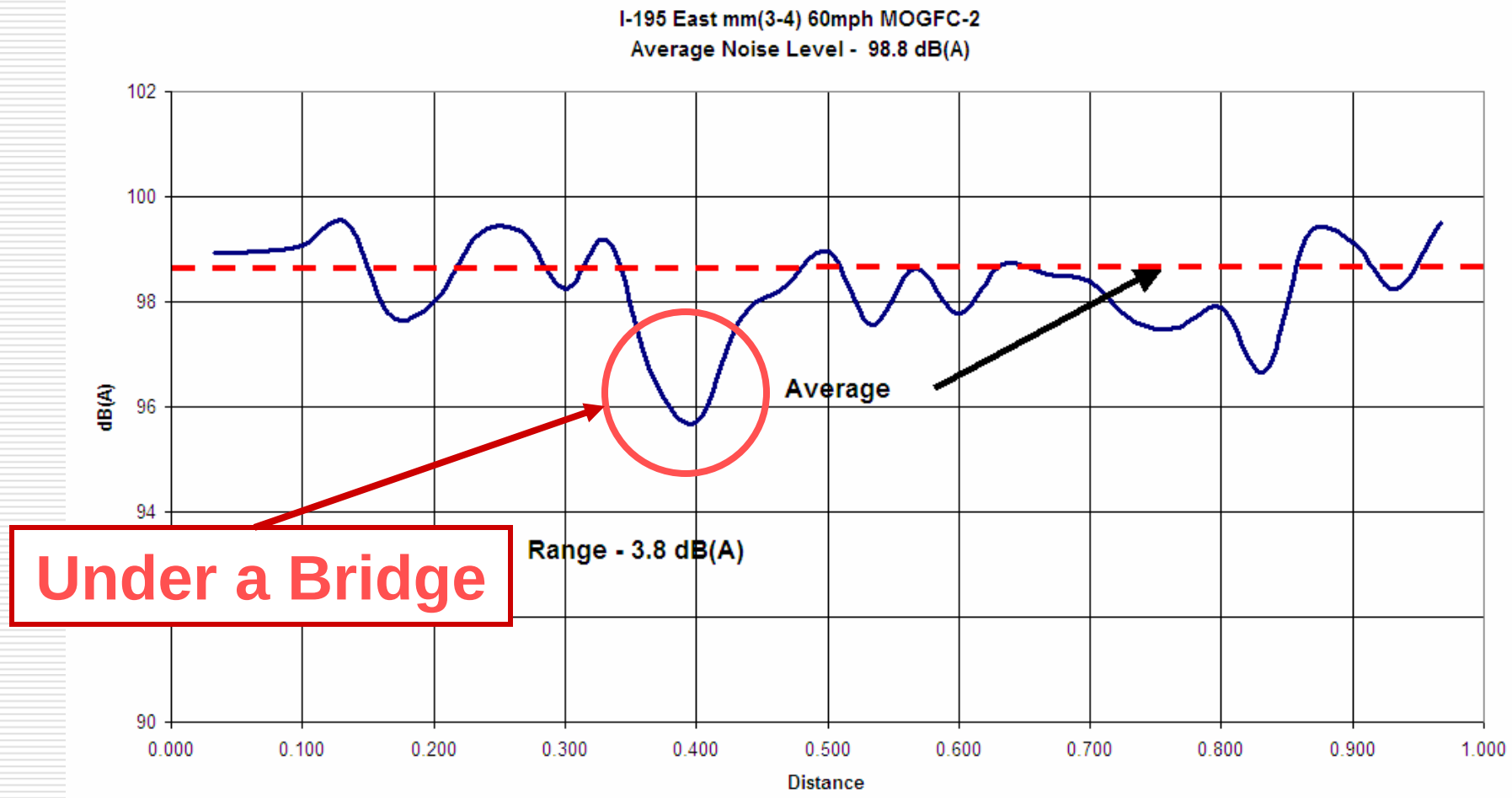


Typical variability

- HMA – Average variability over a one–mile section of roadway – 3.6 dB(A)

- PCCP – Average variability over a one-mile section of roadway – 4.4 dB(A)

MOGFC - 2


I-195 East mm(3-4) 60mph MOGFC-2
Average Noise Level - 98.8 dB(A)
102
100
98
96
94
90
dB(A)
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
Distance
Average
Range - 3.8 dB(A)
Under a Bridge

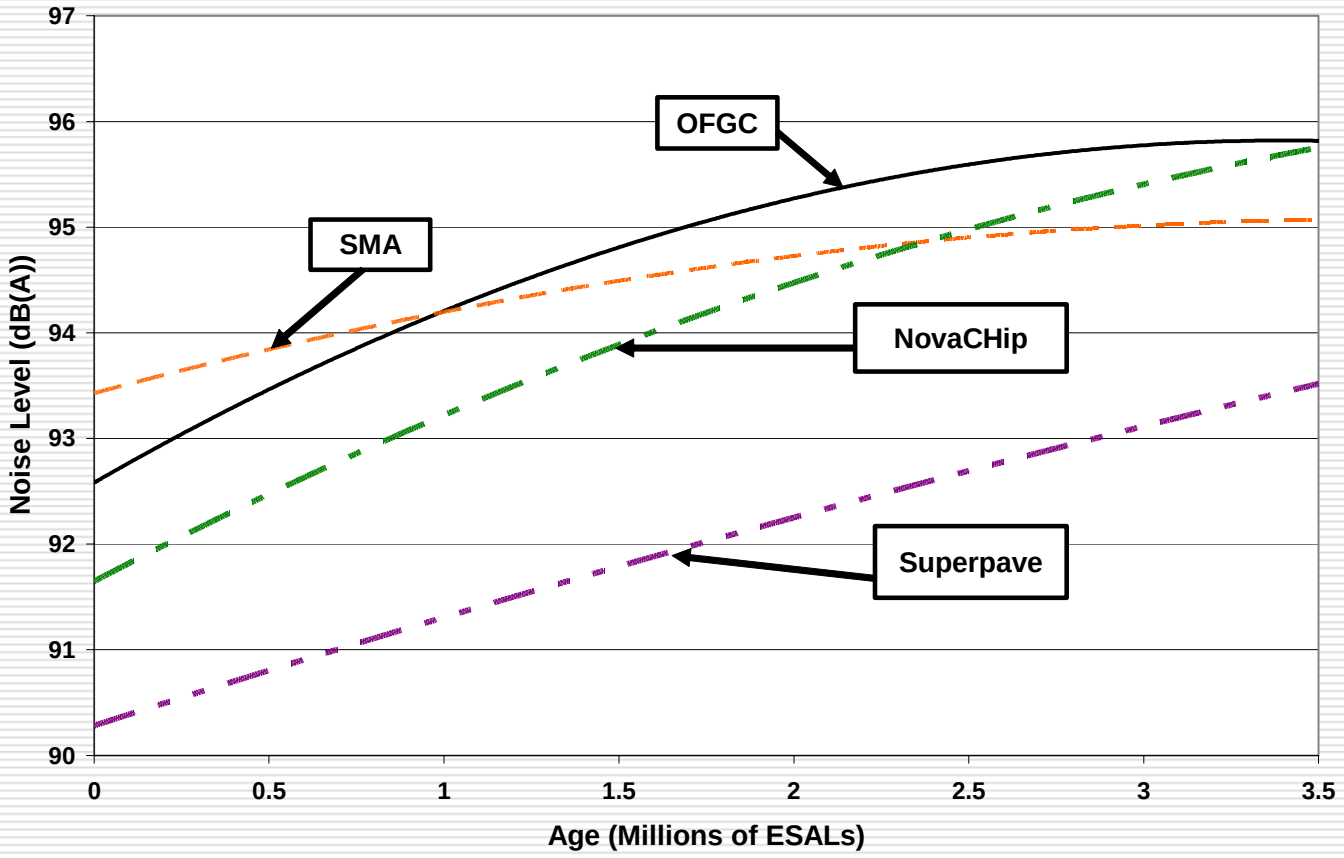
Pavement Under Bridge

Conclusions

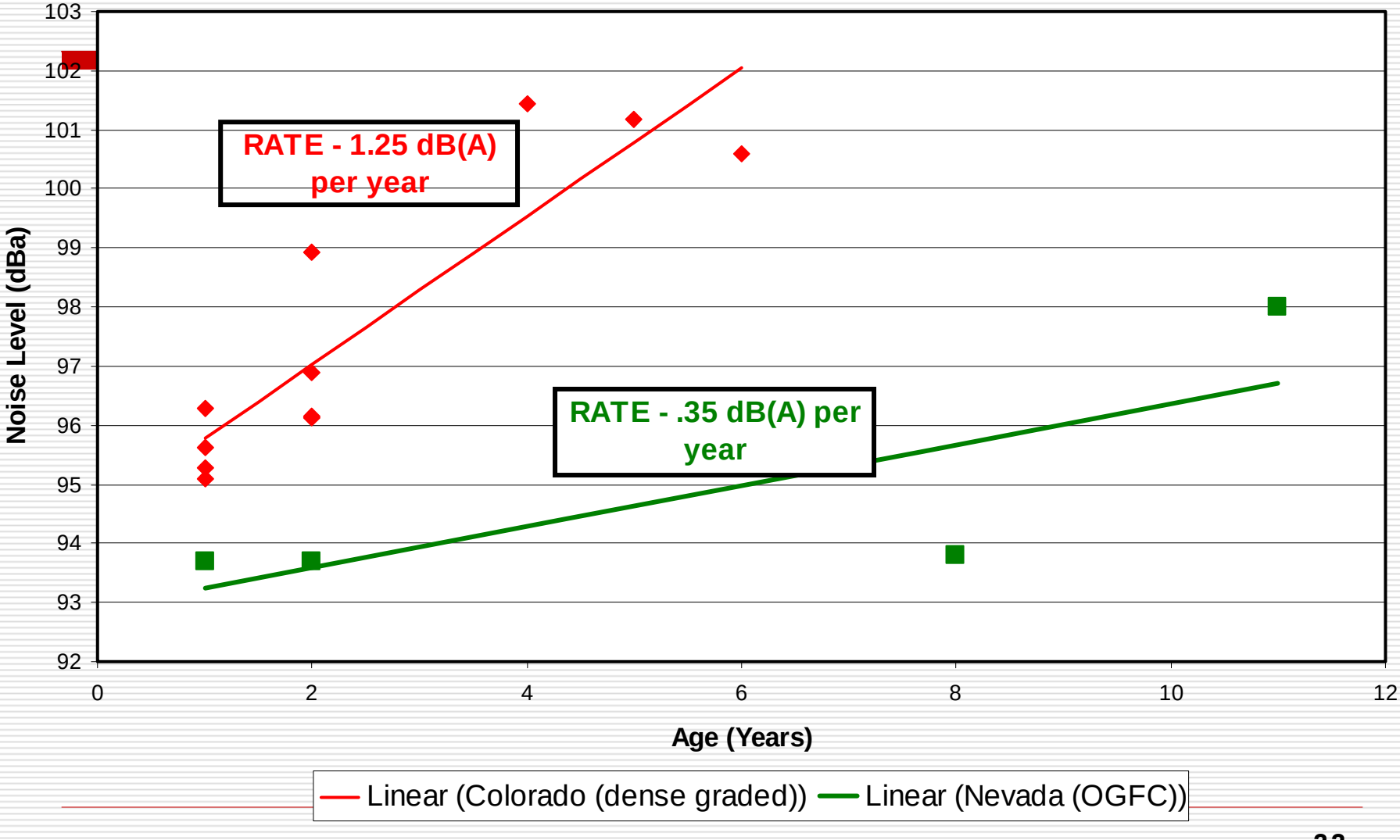
- The noise level of a highway is a lot more variable that most folks doing noise testing understand it to be.
- This variability needs to be considered when doing side line measurements
- You can pick – low or high noise areas depending on what you want to prove

Effect of Age on Noise

Test Track


97
96
95
94
93
92
91
90
Noise Level (dB(A))
OFGC
SMA
NovaCHip
Superpave
0
0.5
1
1.5
2
2.5
3
3.5
Age (Millions of ESALs)

DGA vs OGFC
(Colorado and Nevada)



What Makes a Difference?

Texture

- Maximum aggregate size
- Negative (rolled) surface

Voids

- More is better

Thickness

- Thicker is better

QUESTIONS ?