OBSI Testing

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Pavement Evaluation 2010
Roanoke, Virginia

Outline

1. Past and future of OBSI testing
2. Need for noise testing
3. Noise measurements as part of PMS
4. University of California example results
5. Summary

Part 1

PAST AND FUTURE OF OBSI TESTING

OBSI

- OBSI is On-Board Sound Intensity
- A method to measure tire/pavement noise using microphones next to a tire
- In use since in pavement engineering since ~2002

Beginnings of OBSI

- It started as tire noise research at GM in the 80's

Caltrans' interest in OBSI

- The Environmental Division of the California DOT has supported research & implementation (Bruce Rymer with Paul Donavan).
  - Initially to adapt the method for quiet pavements
  - To perfect the protocol

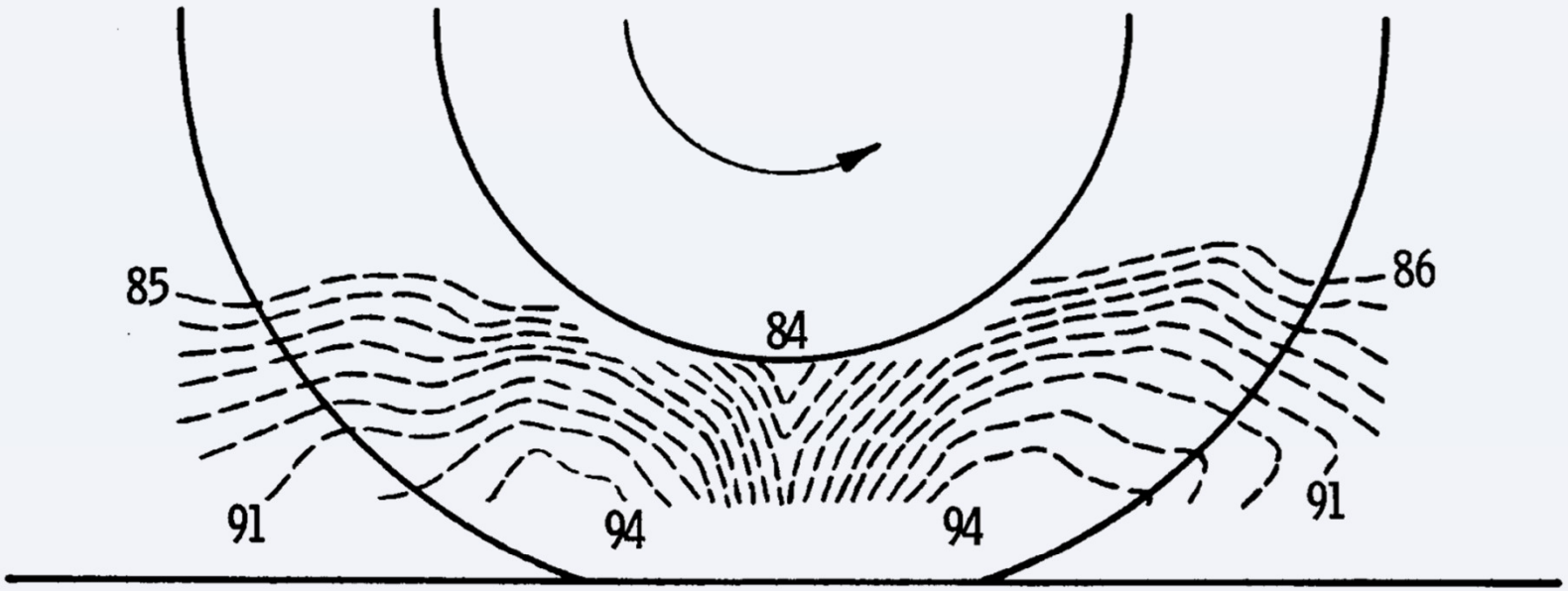
- In 2005 Caltrans tasked the University of California with using the OBSI method for quiet pavement research

Interest in Noise at NCHRP

- Completed Projects (6)
  - **Measuring Tire-Pavement Noise at the Source**
  - Truck Noise-Source Mapping
  - Mitigating Nighttime Construction Noise, Vibrations, and Other Nuisances
  - Predicting Stop-and-Go Traffic Noise Levels
  - New Noise Barrier Products & Noise Barrier Approval Research & Guidelines
  - Smart Sensor for Autonomous Noise Monitoring Completed (IDEA)
- Active (2)
  - Methodologies for Evaluating Pavement Strategies and Barriers for Noise Mitigation
  - Pavement Noise Intensity Testing in Europe for Comparison to the United States
- RFP (1)
  - Supplemental Guidance on the Application of FHWA's Traffic Noise Model (TNM)
- Synthesis Reports (3)
  - Highway Noise Barriers Final
  - In-Service Experience with Traffic Noise Barriers Final
  - Relationship Between Pavement Surface Texture and Highway Traffic Noise Final

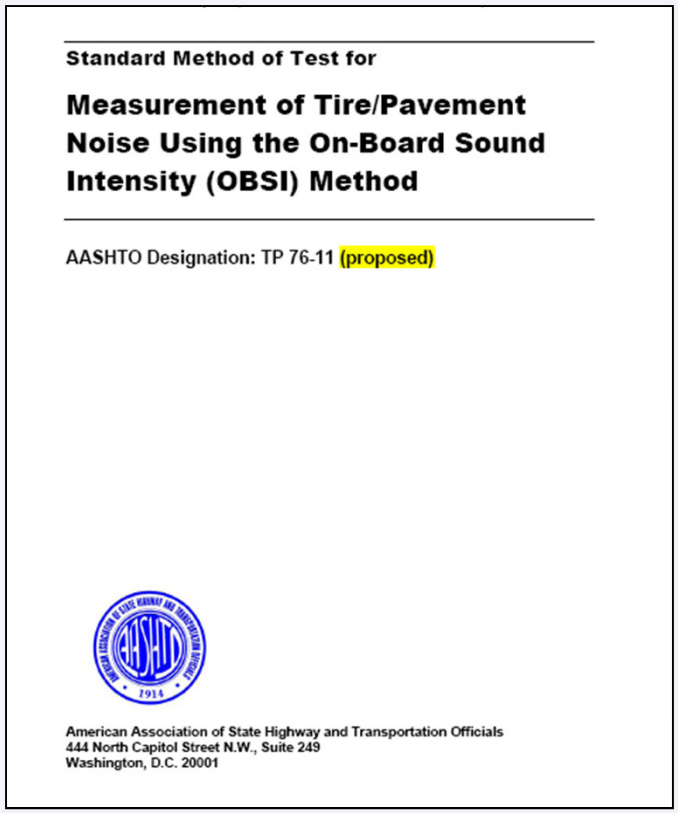
Sound Intensity

GM work was the base for later OBSI specs, like mic location



OBSI Procedure

- General Motors test procedure documented in 1990's
- Caltrans standard practice in early 2000's
  - Applied to quantifying pavement noise performance in in-situ
  - Expanded user community outside California
- Later 2000's
  - OBSI ETG formed – initial AASHTO procedure
  - NCHRP 1-44 on-board measurement research
  - Other standards organizations – SAE & ASTM



Standard Method of Test for

Measurement of Tire/Pavement Noise Using the On-Board Sound Intensity (OBSI) Method

AASHTO Designation: TP 76-11 (proposed)

American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Ref: P. Donavan, TRB ADC40, Jan-2010

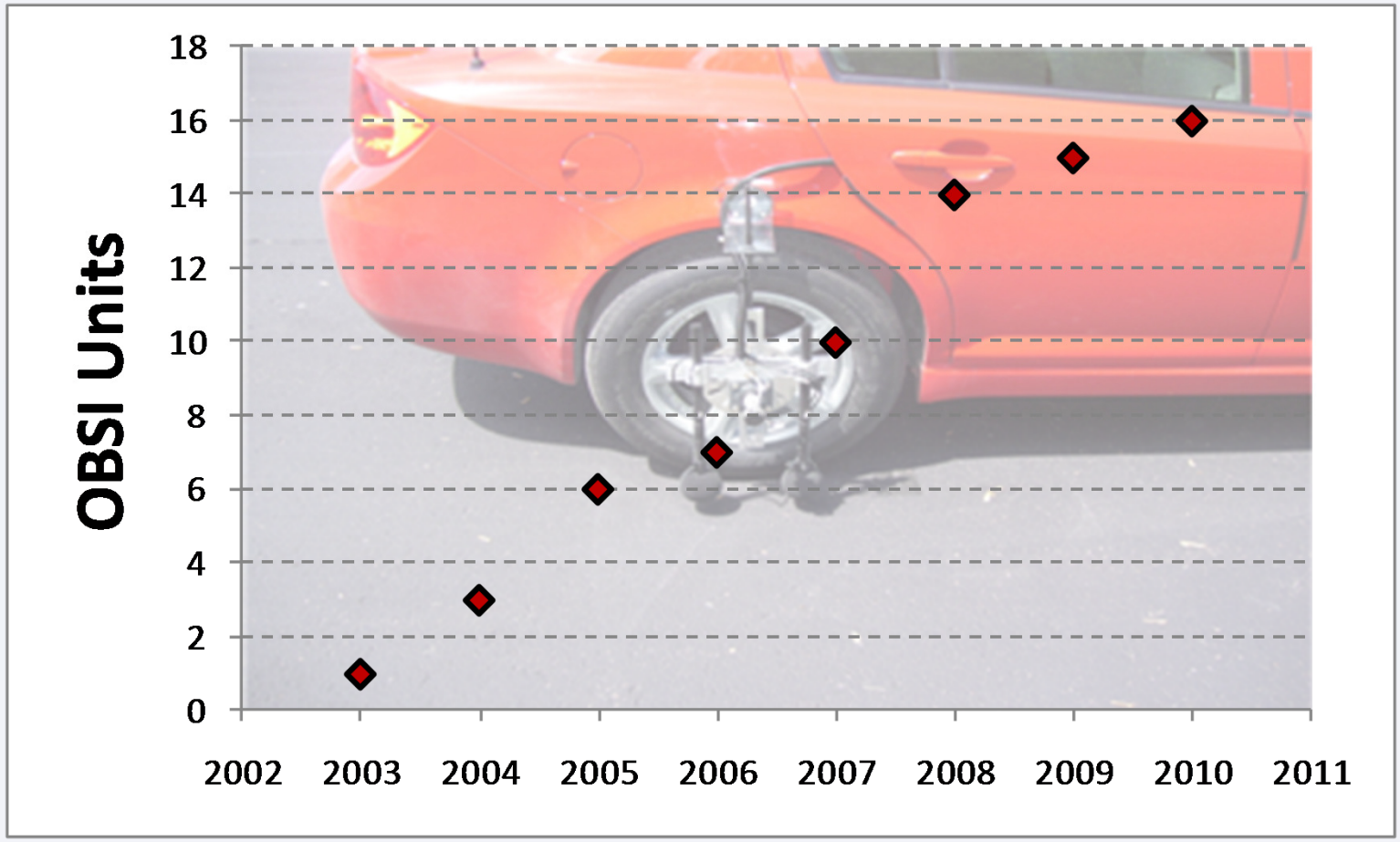
OBSI Developments

- ~2002 P. Donavan refines method to test pavements
- 2004-2005 Three or four “teams” testing OBSI
- 2006 Push for dual probe
- 2007 First “OBSI Rodeos” in California
- 2008 Approximately 10 OBSI units exist in the US
- 2008 Rodeo at GM in Mesa, AZ
- 2009 AASHTO TP76 approved
- 2009 NCHRP 630 published: “Measuring Tire-Pavement Noise at the Source”
- 2010 Investigation into factors affecting OBSI

Evolution of the method

- Single probe to dual probe
- Test tire
- Additional instrumentation (DMI, triggering systems)

Increase in number of OBSI units



Pavement consultants, acoustic consultants, universities, State DOTs(TXDOT, WSDOT, FDOT, MnDOT)

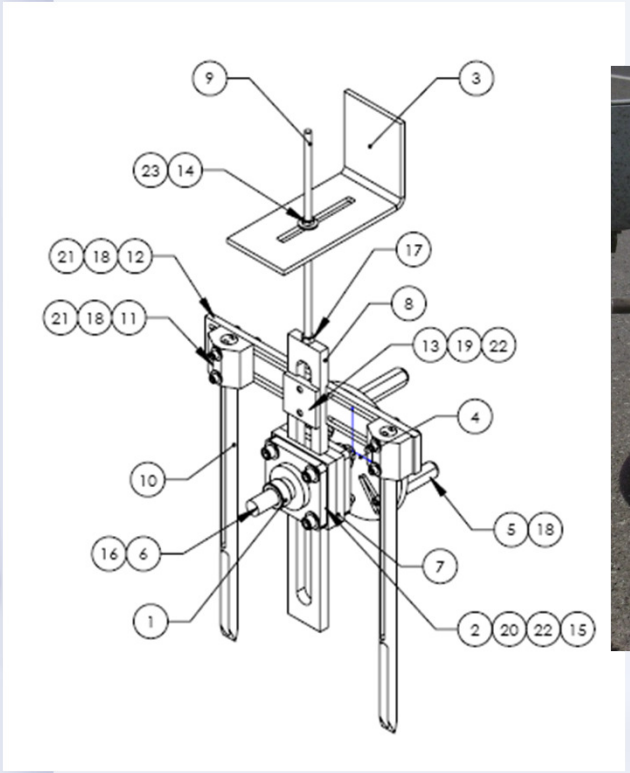
Current typical setup

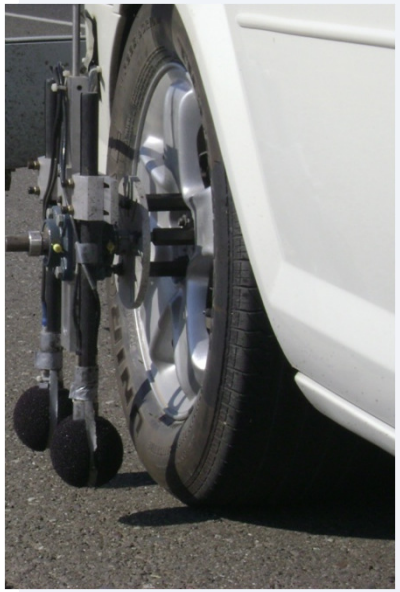
- Two microphone probes, vertically oriented
- Four-channel sound analyzer
- Calibration device
- Test tire

The OBSI method

AASHTO TP 76:

Measurement of Tire/Pavement Noise Using the On-Board Sound Intensity (OBSI) Method





OBSI units

Example of OBSI units

Summary of AASHTO method

- Constant speed of 60 +/- 1 mph
- Check tire, calibrate microphones
- Test 440 feet ←→ 5 seconds
- At least two runs
- Verify data quality:
  - Run-to-run standard deviation (overall and 1/3 octave)
  - Check PI index and microphone coherence
- Air density correction (temperature, barometric pressure)
- Record tire rubber hardness

Part 2

NEED FOR TIRE/PAVEMENT NOISE TESTING

The Highway Noise Problem

- Highway noise complaints increasing in many countries
- More and more noise barriers
- Noise barriers are expensive

Noise Barriers

- Most barriers block the view
- Noise protection only behind the wall
- Barrier on one side, means reflection to the other side


Fin Autopista
America Vespucio Sur

Proximity to Highways

- In the United States there is generally “more space” next to the highways

- But in other places:
  - less or no room for barriers
  - more people exposed to highway noise

Can’t make tall enough barriers!

The best solution?

Treat the noise at its source!

What's the source?

Traffic noise:

1. *Propulsion noise (engine, gear box, exhaust)*
2. ***Tire-pavement noise***
3. *Aerodynamic noise*

Tire/pavement noise

- Typically at speeds above ~35 mph, tire/pavement noise is dominant source

- To reduce traffic noise, effort should be in **tire/pavement noise**.

→ Quieter tires &

→ **Quieter Pavements**

Detractors say

- “why do we care about testing pavement noise”, or
- “tire noise is a fictitious problem”…

Answer

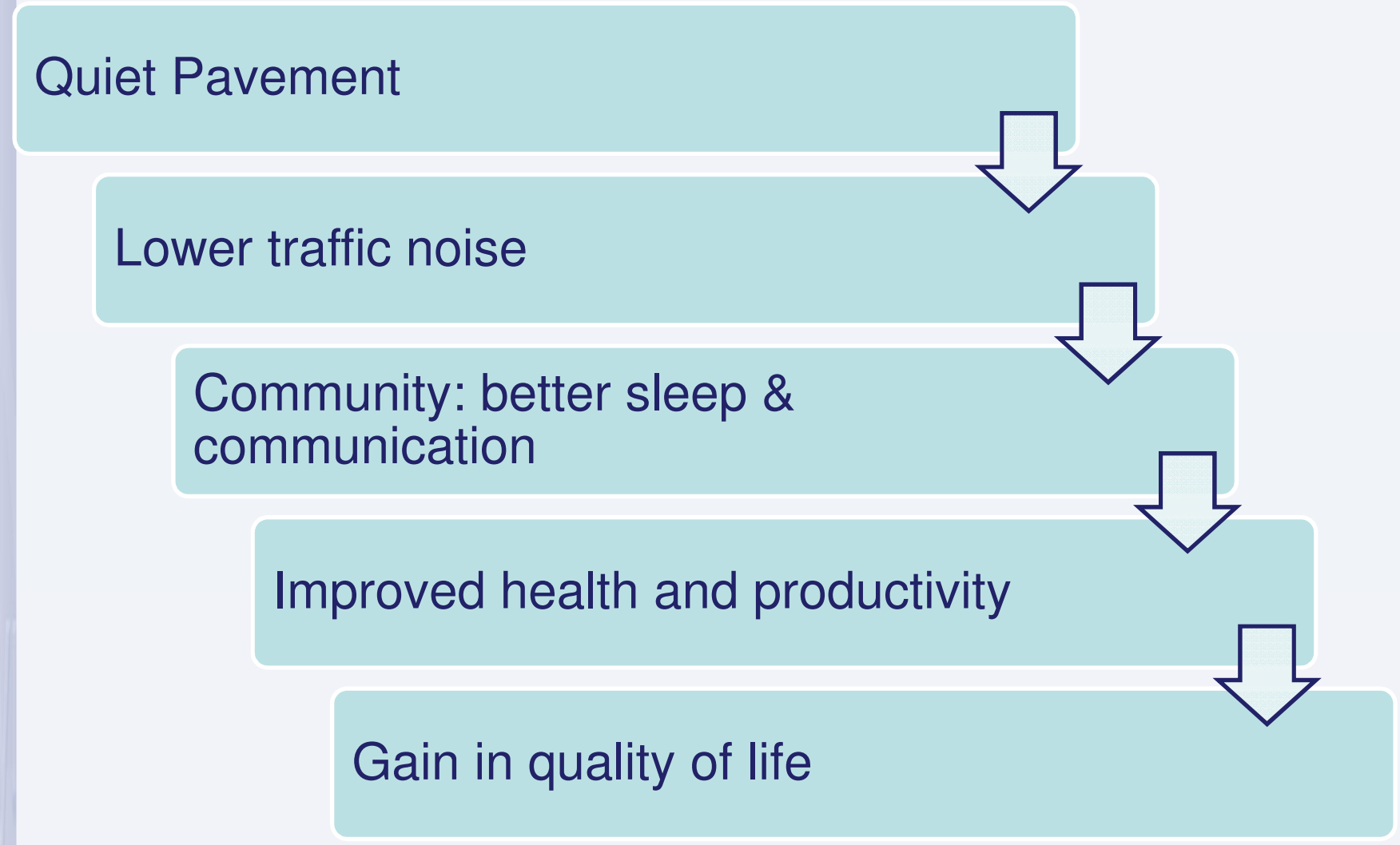
- It is reasonable and appropriate to identify quiet pavement types
- It is a matter of social responsibility to develop and **to use** quieter pavements types
- In developing and using QP, we need appropriate PAVEMENT EVALUATION tools.

“Philosophical approach”

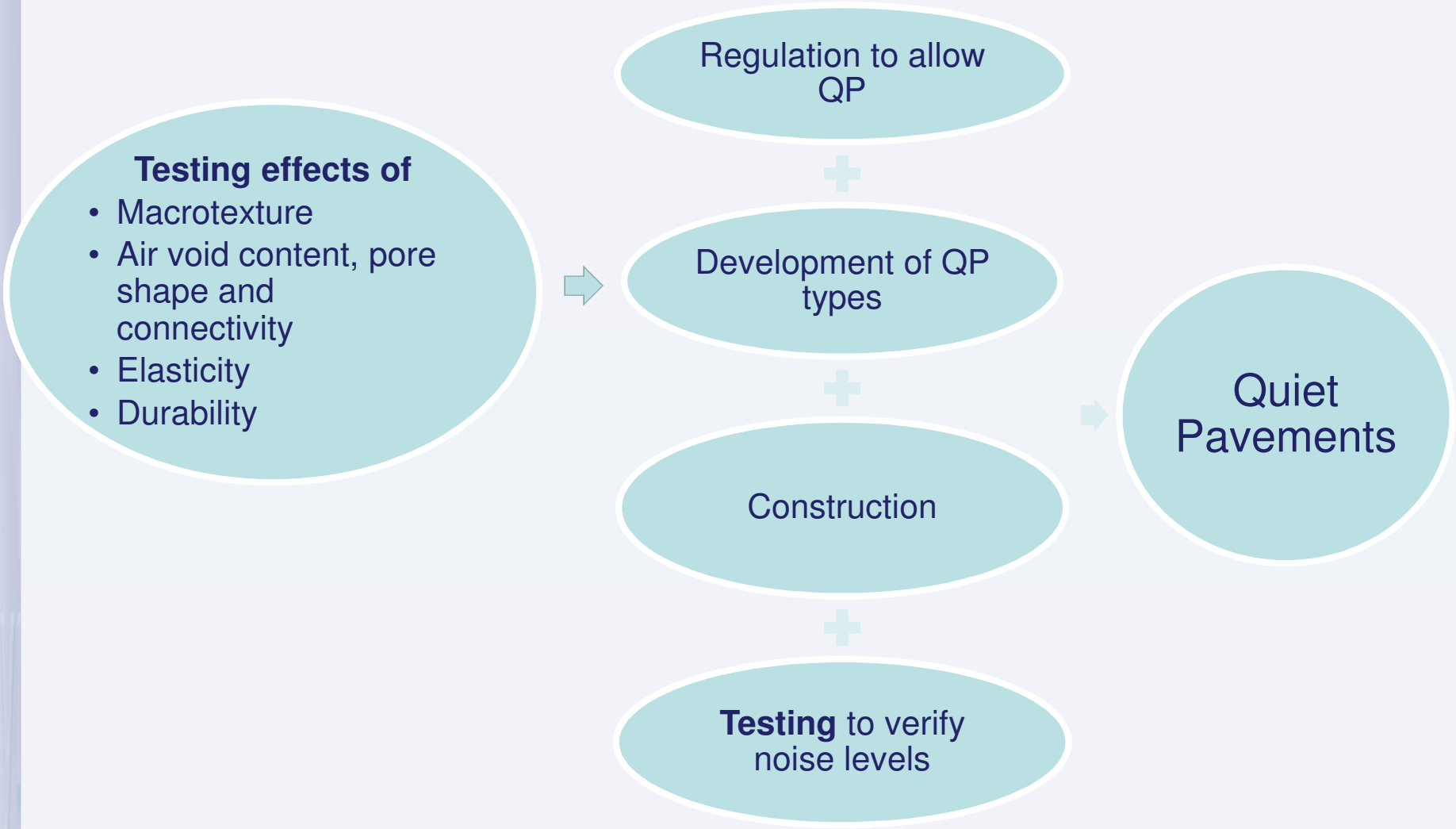
Two basic questions:

1. What do we get out of Quiet Pavement
2. How do we get Quiet Pavement

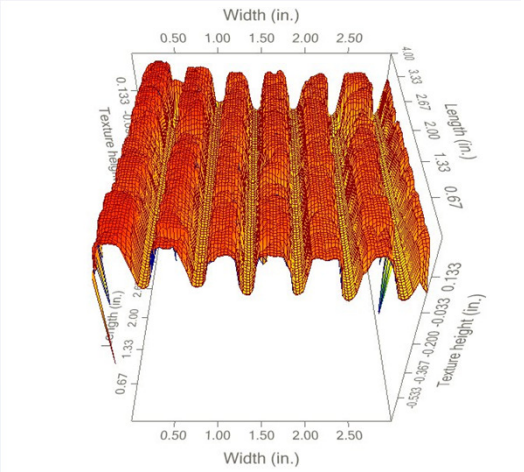
1-What we get from QP?



2-How de we get QP?



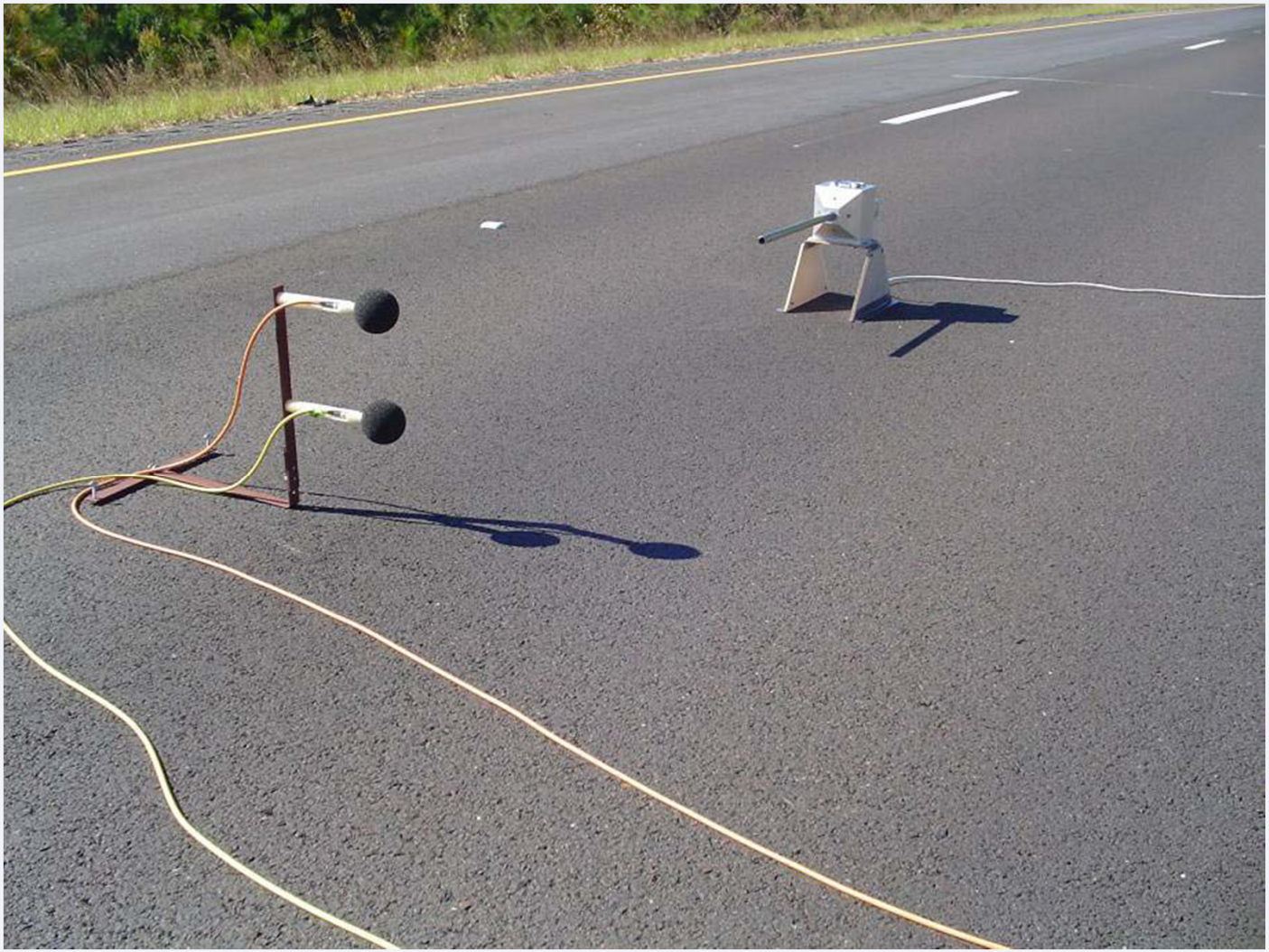
Can we predict noise from macrotexture?



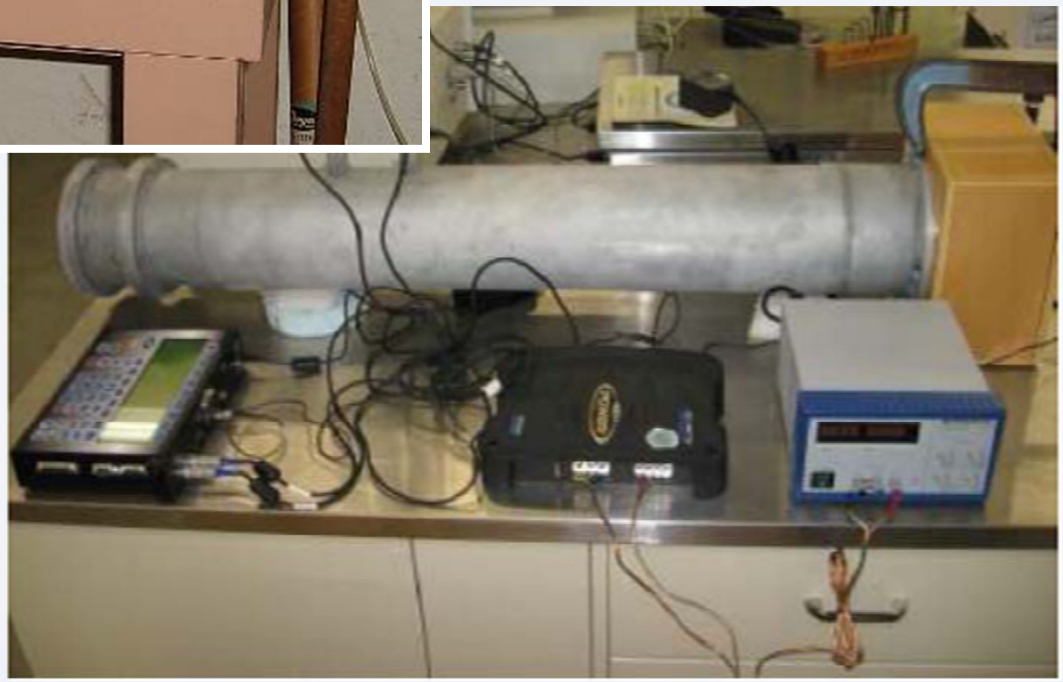
- It's worth exploring, but:
  - Macrotexture affects noise generation
  - Absorption affect noise transmission

- To predict OBSI, we would need to measure both Macrotexture & Absorption

Sound absorption measurement



Ref: Judy Rochat, TRB ADC40, Jan-2010



Ref: E. Kohler 2008, M. Ahammed, 2010

Need for Testing

It doesn't seem easy to predict OBSI in the near future.

If we want to know OBSI levels,

we need to MEASURE OBSI levels

Part 3

NOISE MEASUREMENTS AS PART OF PMS

Keynote Presentation

- Are the measurements…
  - Meaningful?
  - Consistent?
  - Robust?
  - Predictable?
  - Economical?
  - Non-disruptive?

- …YES

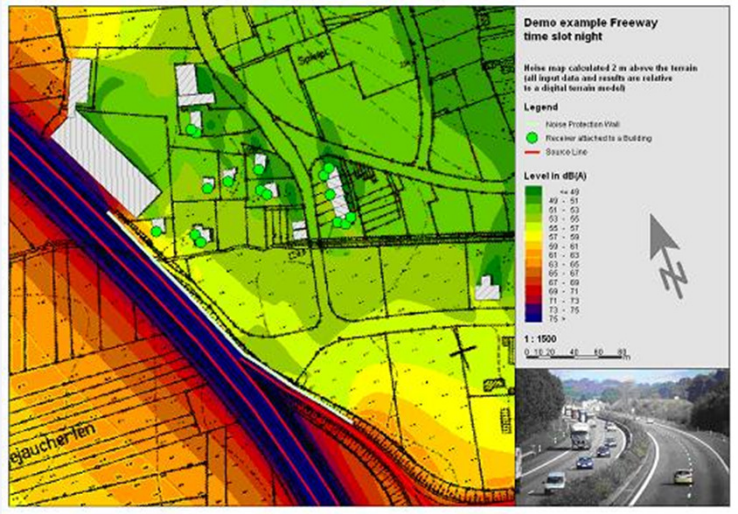
  (certification process?)

Need to evaluate noise levels

- Regulations call for “noise analysis” when potentially impacted receivers are present – NEW PROJECTS

- As the effects of traffic noise in human health are better documented, this begins to extend to – CURRENT SITUATION

- Noise contours



Continuous measurement

- Microphones on the side of the road versus “on board” microphones
  - Testing with stationary mic is expensive
  - OBSI is efficient
  - OBSI allows for sectioning

- OBSI results can be approximately converted to “on the side of the road” levels

In the US

- Modeling of highway noise is done using TNM software (Transportation Noise Model).
- It assumes only one generic pavement type. It is not possible to try different pavement types
- TNM is being updated by the Volpe Center
  - Pavement Effects Implementation Study,
  - Using OBSI data

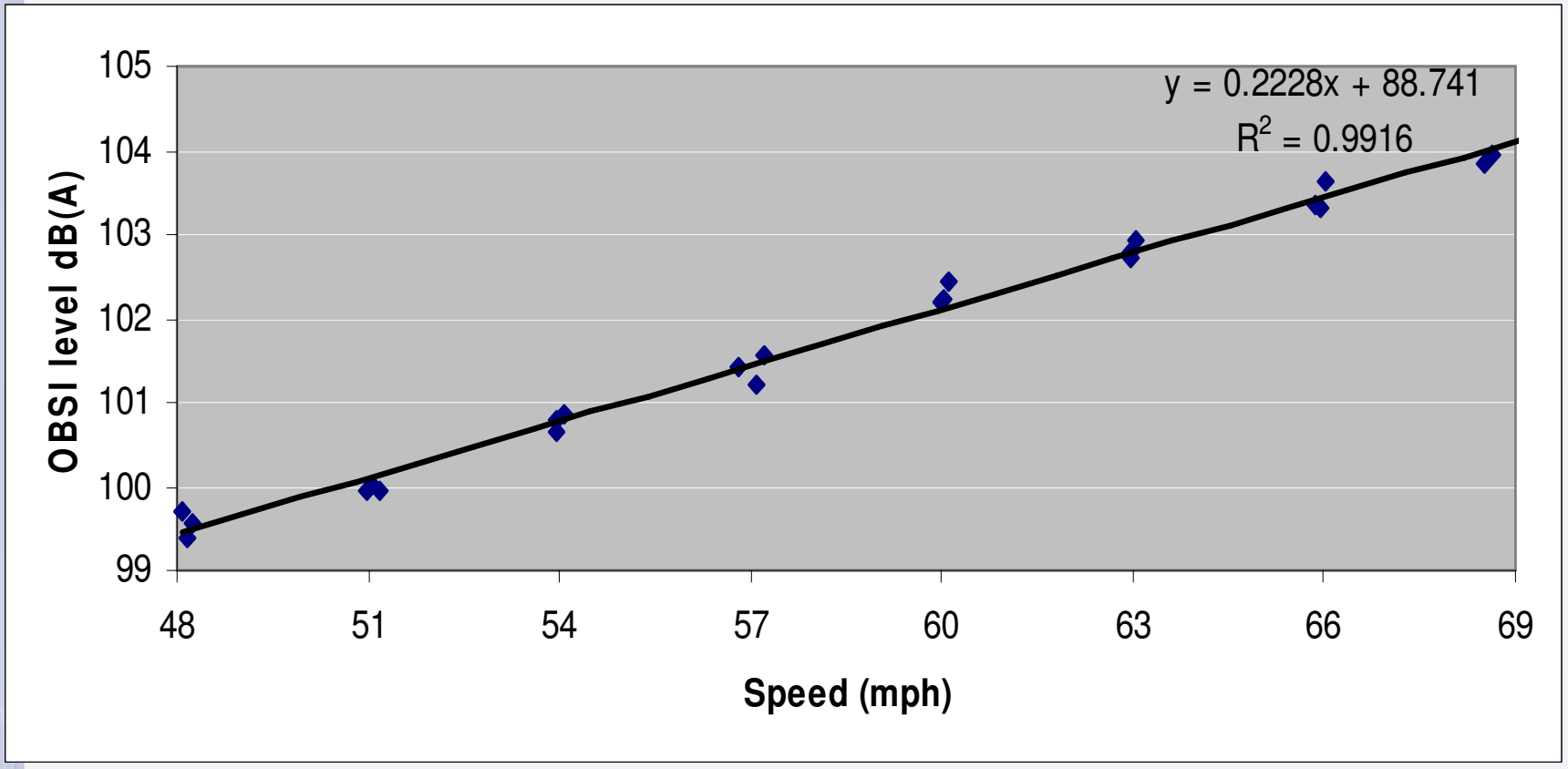
PMS

- Speed accuracy reduces OBSI error
- Keeping a constant speed is not practical if we want to test OBSI over several miles

440 ft ???

- Continuous OBSI versus sampling OBSI, leading to PMS implementation

Effect of test speed – CA Data



- NCHRP: 0.28dB per mph
- California: 0.22dB per mph

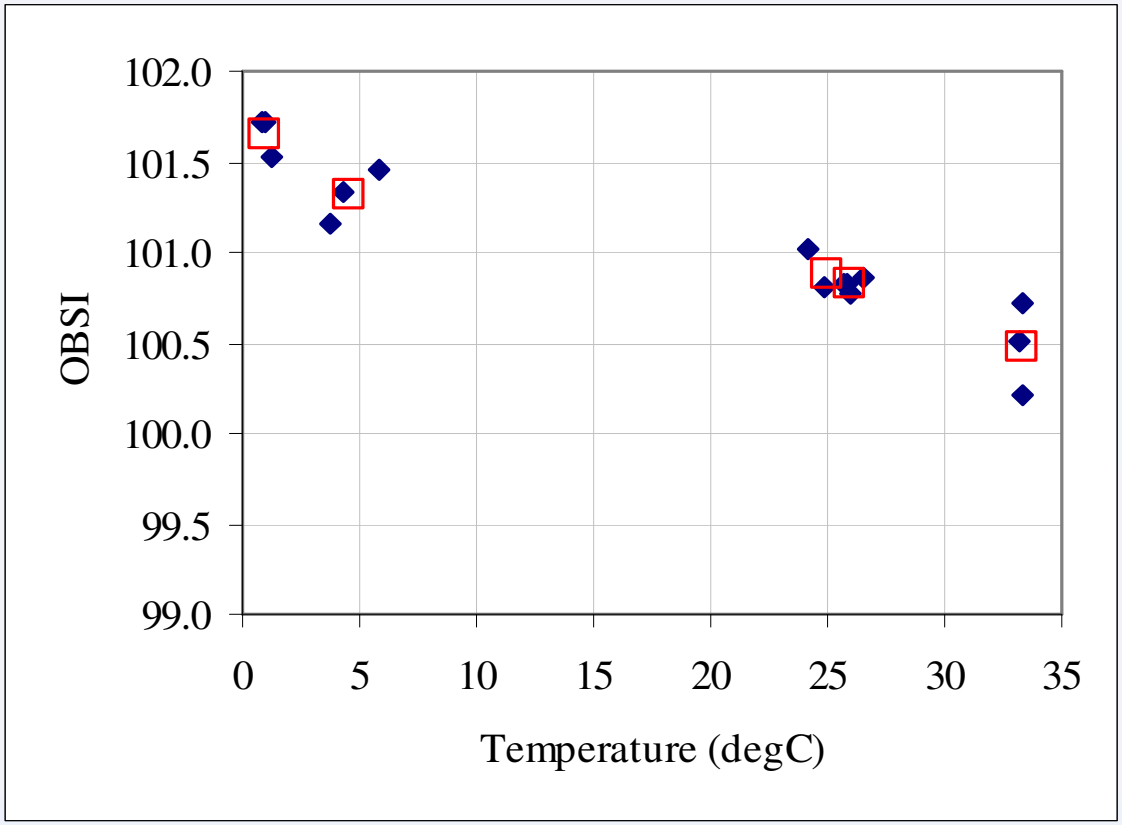
→ let's say **0.25** [more research needed]

Need for speed correction

- Having a speed correction formula (like the 0.25dB per mph), would solve some issues:
  - Specify a range of testing speed (i.e. 55 to 65 mph) instead of constant speed.
  - Speed limit: shouldn't go faster than posted speed limit, but need to compare with 60mph

Pavement temperature effect

- Pavement temperature affects OBSI levels
- Very little has been published



Part 4

UNIVERSITY OF CALIFORNIA EXAMPLE RESULTS

UCPRC Research for Caltrans

- UCPRC has evaluated OBSI for Caltrans since 2005.
- Monitoring of 50+ asphalt sections. Currently 5th year
- Evaluated 120+ concrete pavement sections, 2nd year

UCPRC Equipment

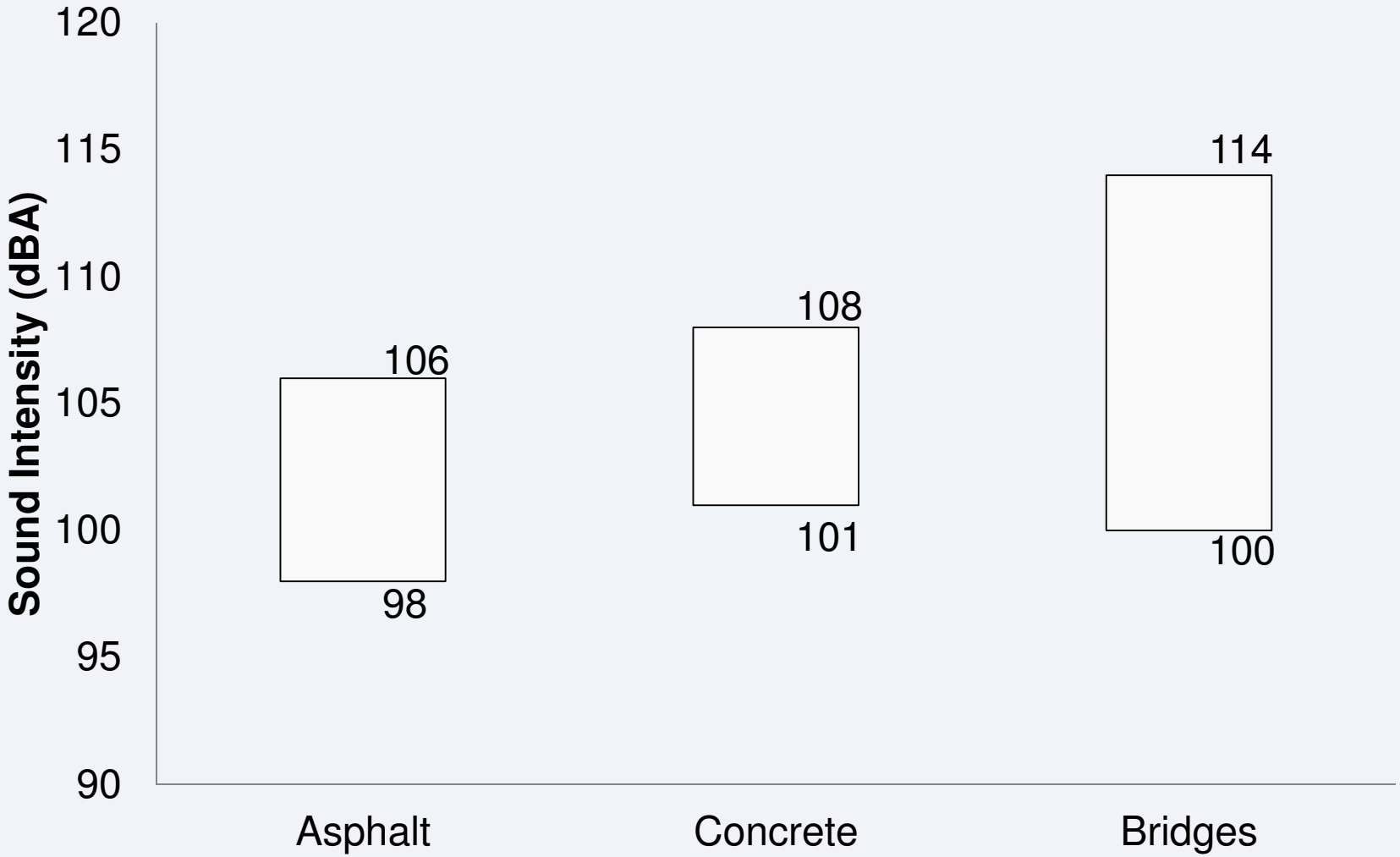
- OBSI
- Profilometer (with macrotexture sensor on right wheelpath)
- Simultaneous triggering for OBSI and profilometer (reflective tape)
- GPS
- ROW camera (low res)


Pavement Test Vehicl
UCPRC
UNIVERSITY of CALIFORNIA PAVEMENT RESEAR
Davis • Berkeley CENTER
1199373

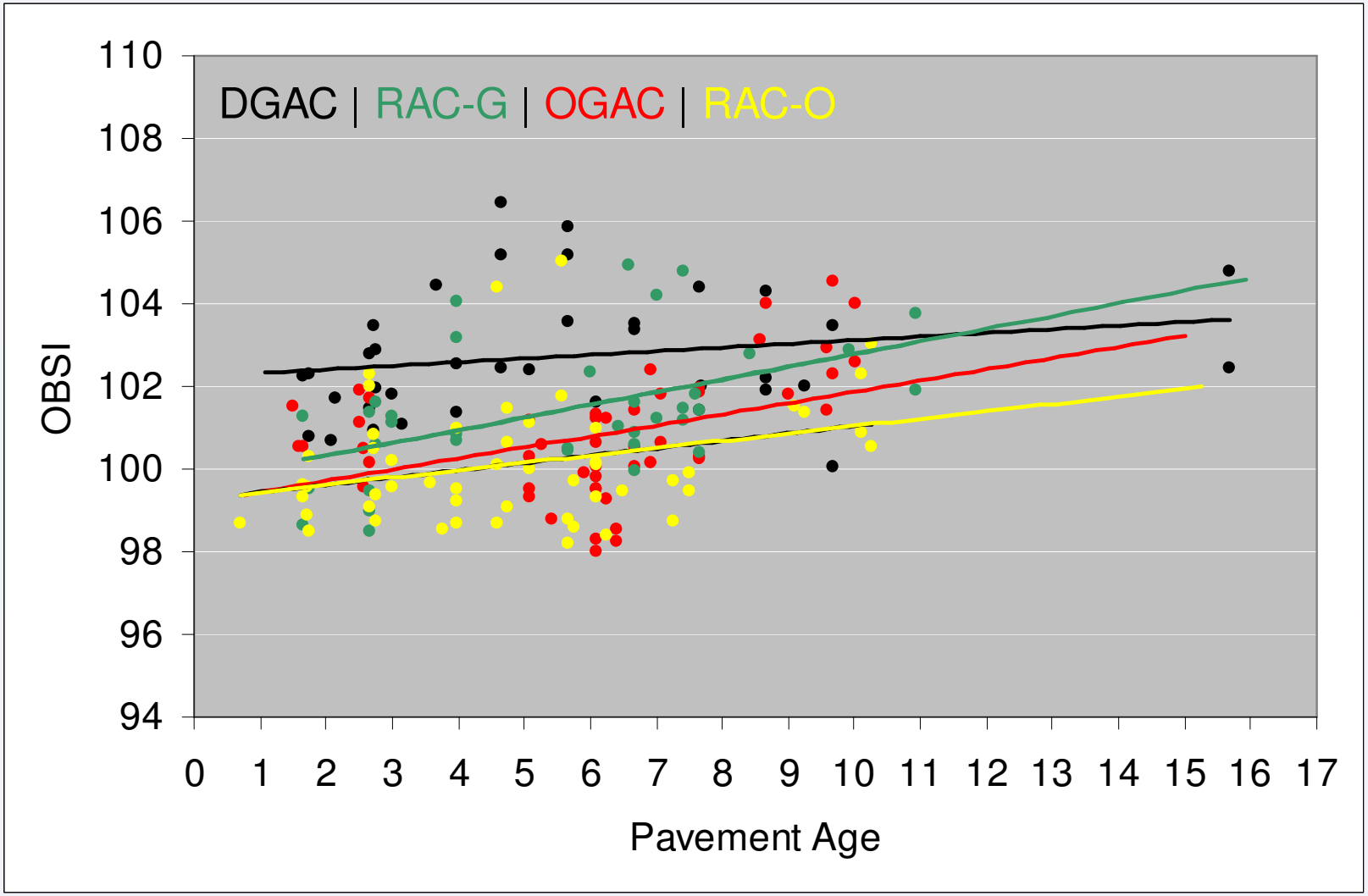
QP studies

	Asphalt	Concrete	Bridge decks
Pav. Types	1. Dense graded 2. Open graded 3. Rubberized OG 4. Gap graded	1. Diamond ground 2. Diamond grooved 3. Longitudinal tined 4. Longit. broomed 5. Burlap drag	1. Transverse tined 2. Transv. broomed 3. Polyester 4. Diamond ground 5. Burlap drag 6. Asphalt concrete
Pav. Age (years)	0 to 12	0 to 60	0 to 16
Monitoring	2005-2010	2009-2010	2009-2010
OBSI levels (dBA)	98 to 106	101 to 108	100 to 114

California OBSI Ranges



OBSI vs Pavement Age (Asphalt)



Longitudinal Tines

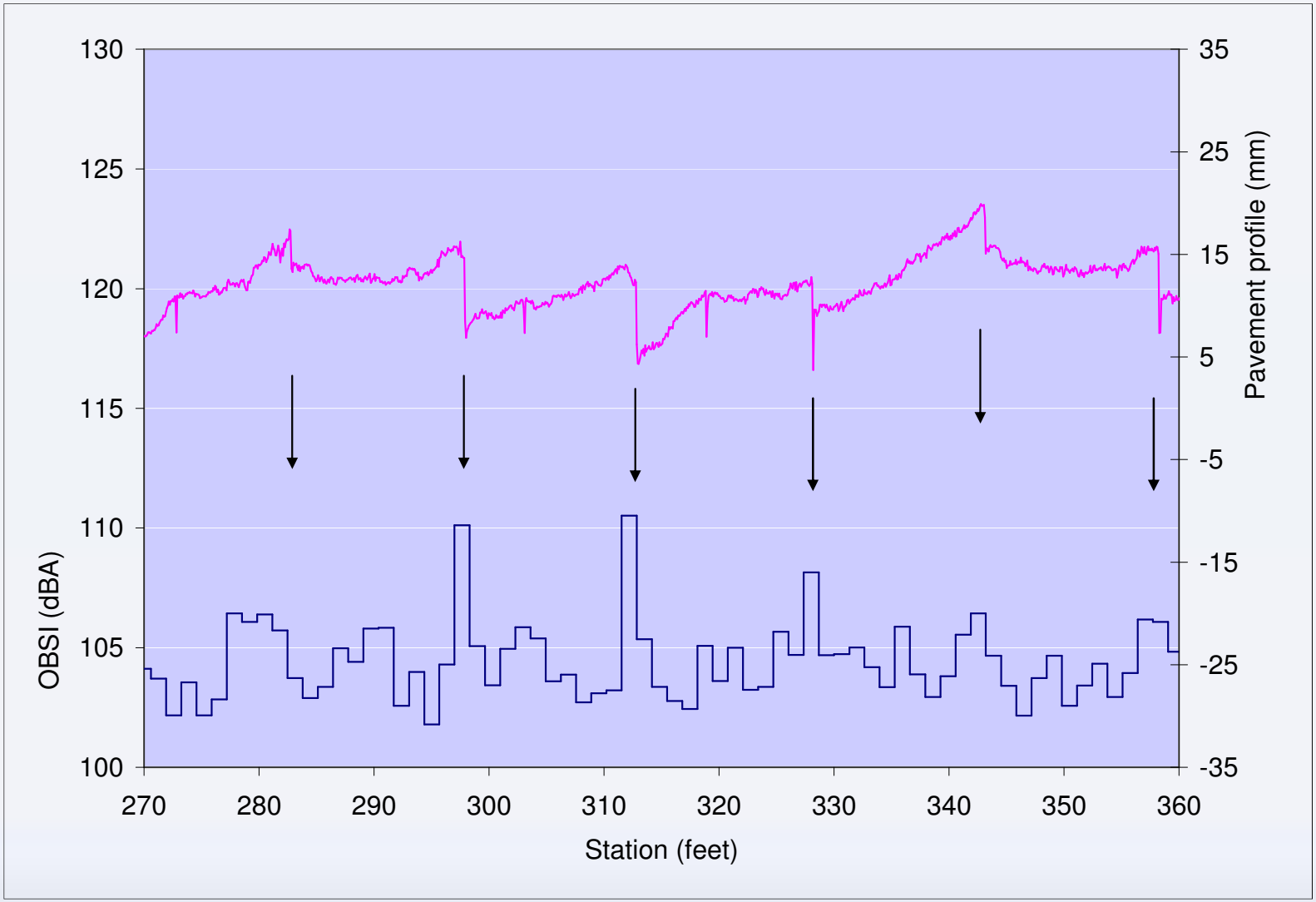

CALL
BOX
Pavement Test Vehicle
60mph
When Flashing
1199373
QP-115

Burlap Drag

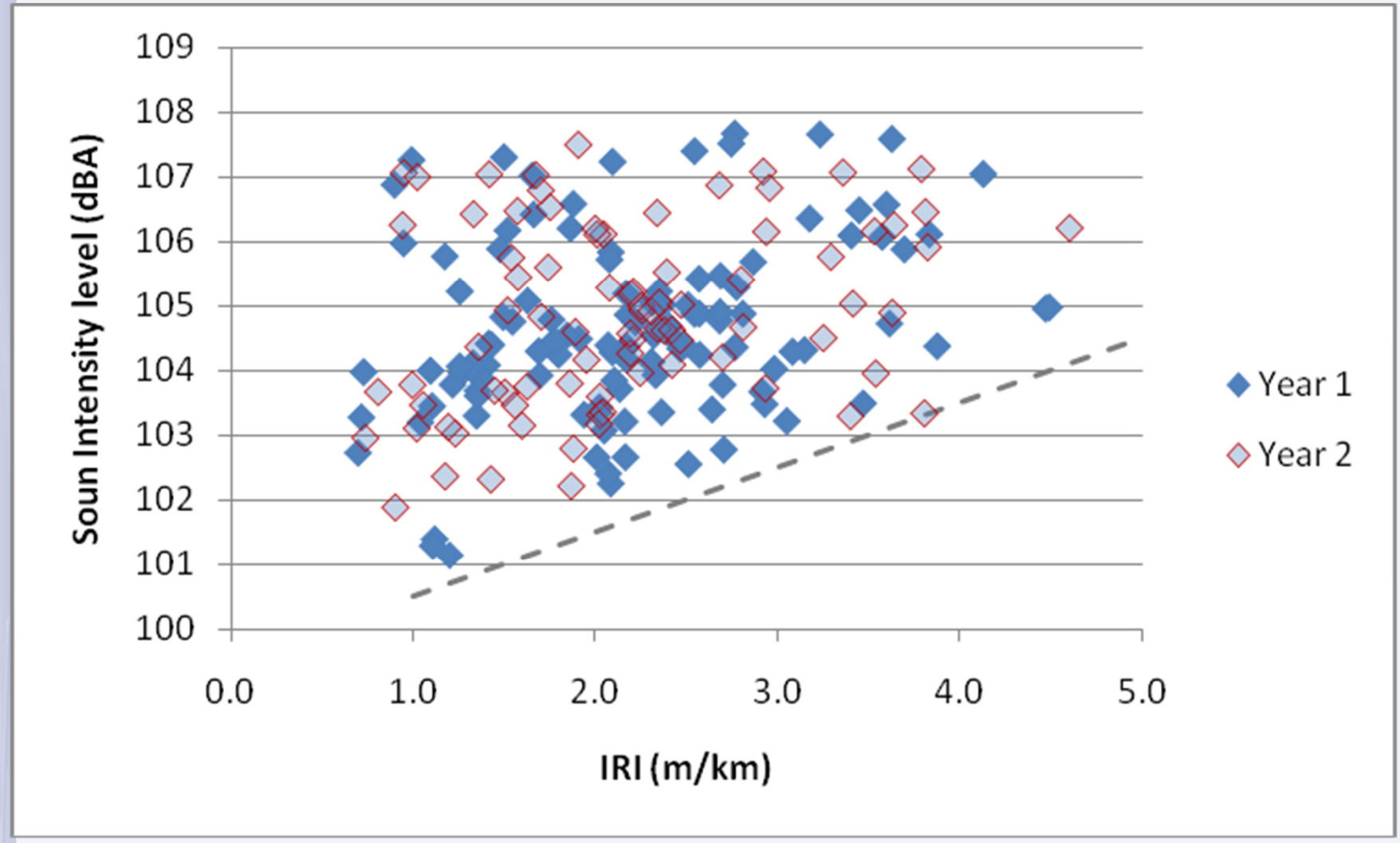

Midway Rd
Lewis Rd
NEXT RIGHT
Pavement Test Vehicle
1199373

Diamond ground

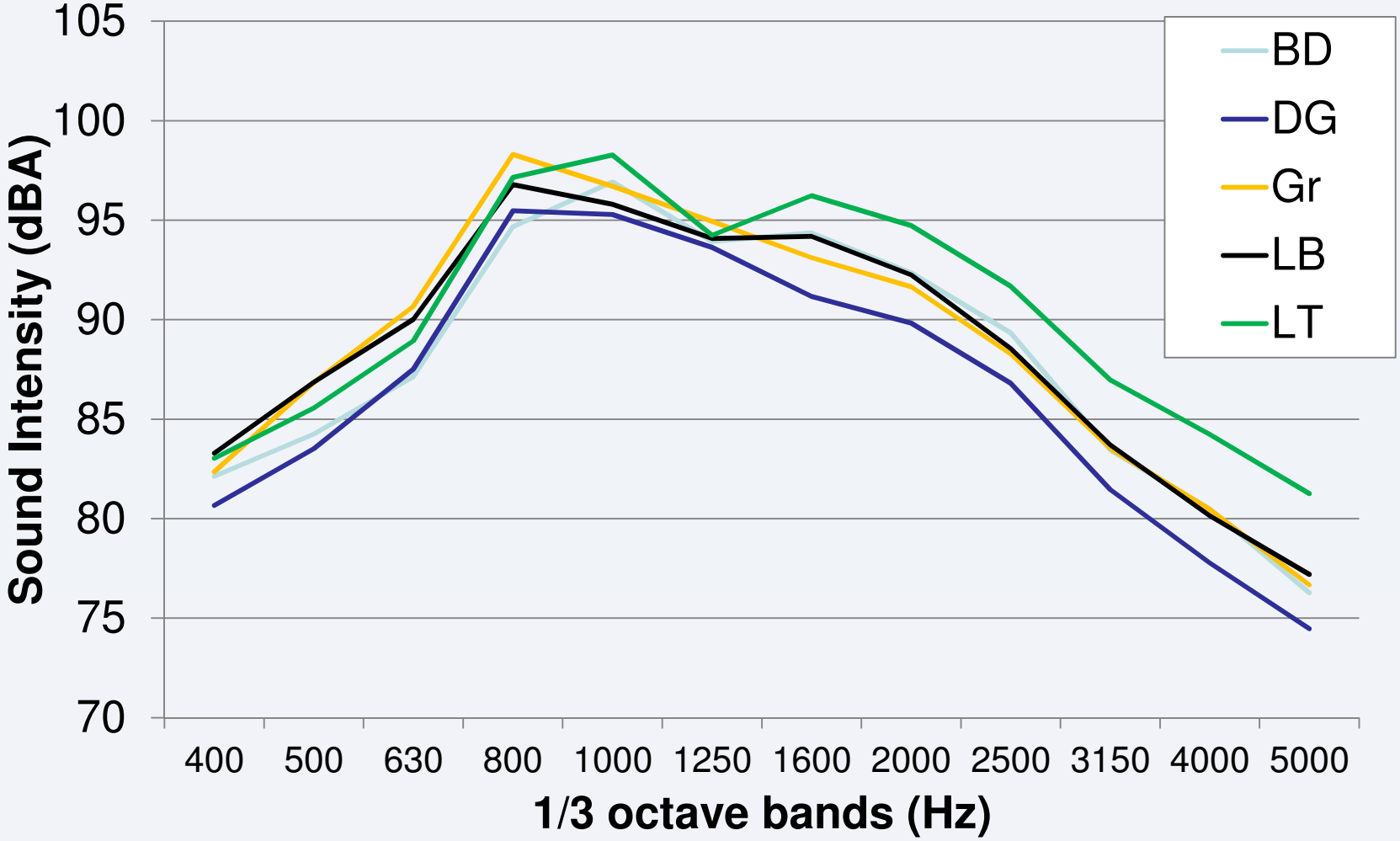
Effect of faulting on OBSI



OBSI vs IRI (PCC pavements)

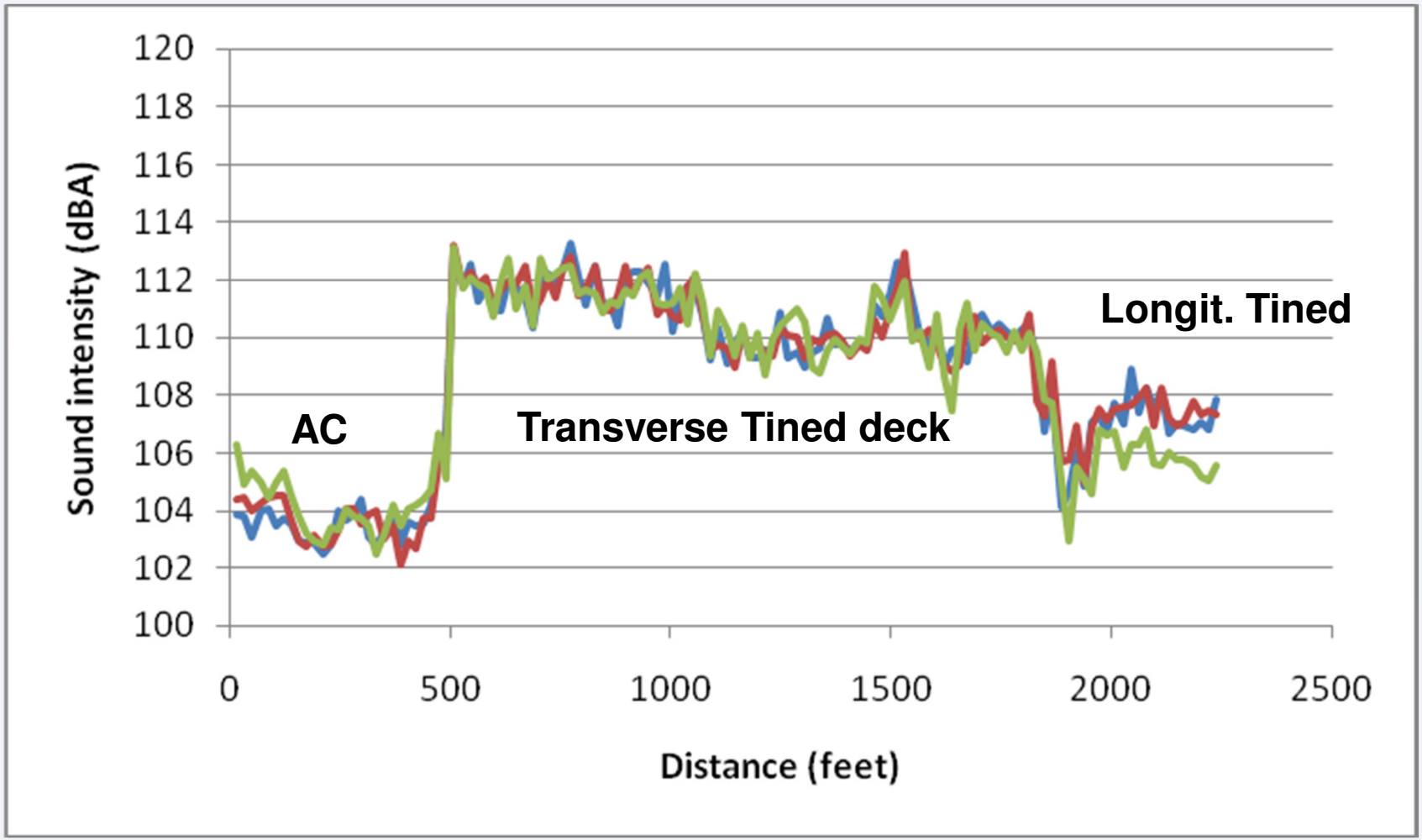


Example noise spectra PCC



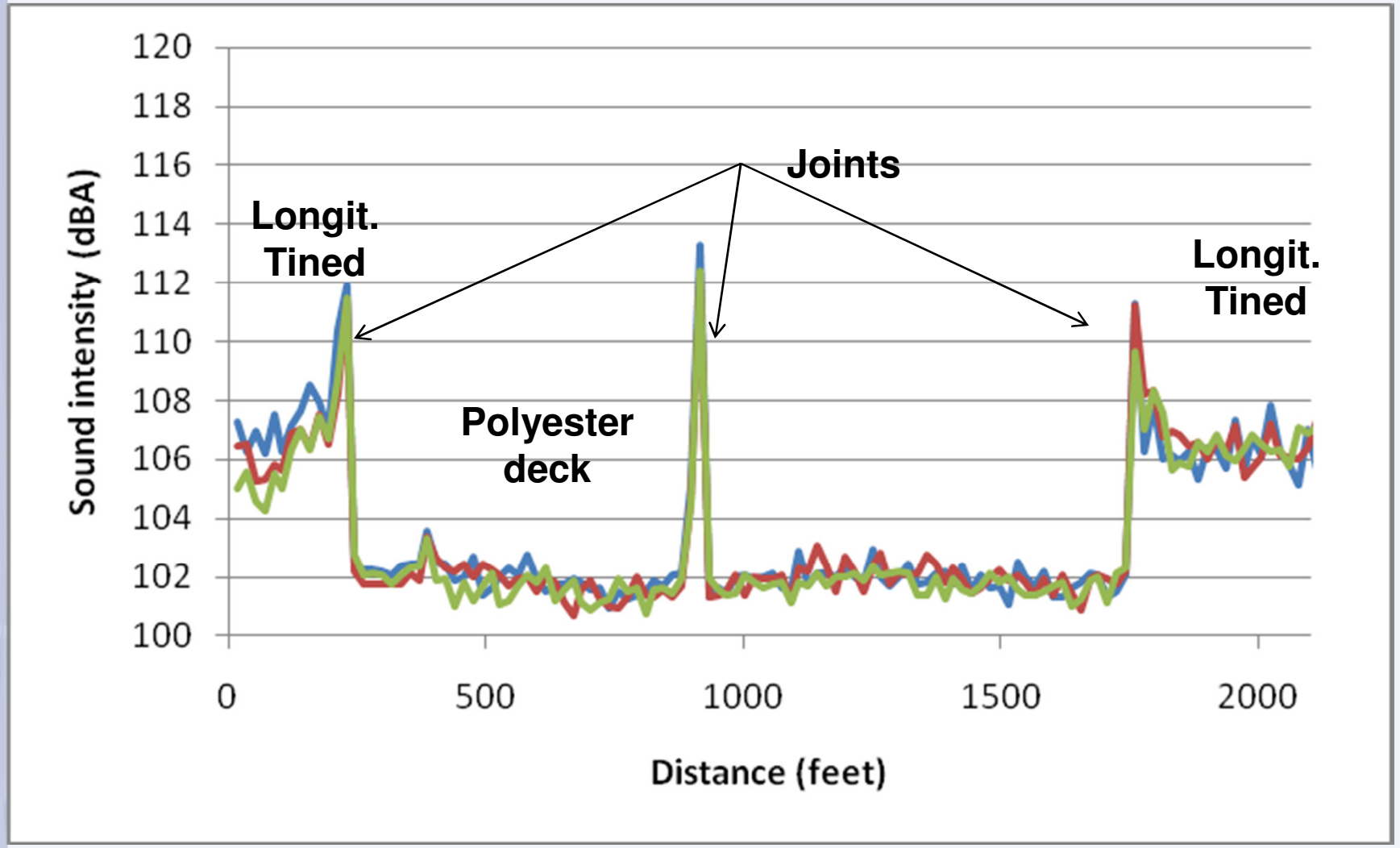
Noisy Bridge in Richmond, CA

Pav-Bridge-Pav



Texture

Pav-Bridge-Pav



Quiet Bridge near Truckee, CA

SUMMARY

Summary

- OBSI has evolved in the last 8 years, and continues to be improved
- AASHTO method to take samples over 440 ft
- Noise barriers are good, but better if we could address traffic noise at the source
- OBSI helps to develop and use QP
- It could be part of PMS (speed and temperature corrections)
- Substantial amount of data in several states

Thank you

ekohler@dynatest.com