EFFECTIVENESS OF NOISE REDUCING ASPHALT PAVEMENTS

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1 Abstract

As vehicles pass over a roadway surface, noise is created due to the interaction between the tires and the pavement surface. For most vehicles travelling at speeds in excess of 60 km/h, the majority of the noise emitted by the vehicle comes from the tires. Noise reducing asphalts operate by affecting the noise generation mechanisms, and through providing an acoustically absorptive surface for sound waves travelling outward from the vehicle. On-board sound intensity measurements were used to evaluate reductions in tire noise for several pavement types, as part of testing for the Ontario Ministry of Transportation. Measurements were conducted over several years to quantify the longevity of any measured noise reduction. Comparisons are made versus other published test results.

2 Introduction

Novus Environmental Inc. (Novus) was retained by the Ontario Ministry of Transportation (MTO) from 2010 through 2014 to undertake On-Board Sound Intensity (OBSI) noise measurements of sound levels from noise reducing asphalts on the Hamilton-bound section of Highway 405, between Station 12+000 and 14+500. These are quiet pavement test sections, paved in fall 2009, where MTO tried several asphalt mix types intended to reduce tire/pavement noise.

The purpose of the measurement program was to evaluate the noise generation of five test pavement sections, through OBSI measurements, conducted using the method outlined in the then-current AASHTO TP-76-12 test method.

3 Test Sections

Five (5) 500-m long test sections, including a normal pavement control section, were tested.

Test Section	Pavement Mix Type and Thickness
A	30mm OGFC, over 50mm HL4 OBC
B	30mm OGFC, over 50mm Superpave 19.0
C	30mm RAC-O, over 50mm Superpave 19.0
D	30mm SMA 9.5, over 50mm Superpave 19.0
E	40mm Superpave 12.5 FC2, over 50mm Superpave 19.0 – CONTROL

Table 1: Pavement Test Sections

The noise reducing asphalts tested included two open-graded friction course (OGFC) types, an open graded rubberized asphalt concrete (RAC-O), and an open graded stone mastic asphalt (SMA). Open graded "popcorn" type pavements have particular size fractions of the aggregate sifted out prior to mixing. The resulting pavement has air voids and gaps between relatively coarse stones.

Figure 1: Open graded pavement (OGFC) versus Typical Control pavement (Superpave HMA)

Noise reducing asphalts operate by affecting the noise generation mechanisms, and potentially through providing an acoustically absorptive surface for sound waves travelling outward from the vehicle.

4 On-Board Sound Intensity Measurements

The OBSI method allows for noise emissions from the tire / road to be measured directly, and allows for various pavement types to be compared. Phase-matched microphone pairs in a "side by side" configuration are attached to the wheel hub at fixed distances and locations from the tire on a given vehicle. The probes are located to capture noise generated at the beginning (leading edge) and end (trailing edge) of the "contact patch". A standard reference tire is used.

The orientation of the probes allows for the "sound intensity" (sound power level flux per unit area) originating from the tires to be directly measured, eliminating noise from extraneous sources, such as wind noise.

In this assessment, the procedures outlined in the American Association of State Highway and Transportation Officials (AASHTO) Standard TP-7-12, Standard Method of Test for Measurement of Tire/ Pavement Noise Using the On-Board Sound Intensity (OBSI) Method were used. Additional guidance was obtained from the National Cooperative Highway Research Program Report 630.

The test sections were paved in 2009. Measurements were conducted in 2009 (by another firm), 2010, 2012, and 2013 (all by Novus), to study the noise reductions due to the asphalt types, and the longevity of any reductions identified. In addition, the 2013 measurements were conducted before and after a vacuum truck cleaned the pavement, to see what effect that would have on the results. Measurements were conducted at 80 km/h and 100 km/h, representing typical highway posted speed limits.

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Figure 2: AASHTO-complaint OBSI Test Rig Used in Measurements

Test Section	Sound Intensity (dBA) Relative to Control (Section E)				
	2009	2010	2012	2013	2013 Cleaned
A	-4.5	-3.7	-1.7	-2.6	-3.4
B	-1.9	-1.1	-0.3	-1.6	-2.4
C	-3.8	-3.2	-1	-0.9	-1.4
D	-2.8	-0.5	1.7	0.9	1.0
E	-	-	-	-	-

Table 2: Comparison of test results (100 km/h) versus control pavement (Section E) over time.

5 Results

A review of the measurement results shown in **Table 2** indicates the following trends:

- Overall average sound intensity levels measured became progressively louder for the first 3 years after installation.
- The 4th year following installation did not significantly affect sound intensity levels.
- Different pavements deteriorate at different rates.
- Cleaning did not restore the asphalts to original intensity levels.

A comparison of the OBSI results versus the results from the Noise Intensity Testing in Europe (NITE) Studies I and II has been conducted. The results are shown in **Figure 3** below.

The measured values for sound intensity, sorted by type of pavement, generally fall into the NITE measured ranges.

6 Conclusions

A review of the measurement results indicates that noise reducing asphalts provide only modest reductions in noise level (< 3dB); that their effectiveness quickly decreases with time; and that cleaning provides only a marginal improvement.

Acknowledgments

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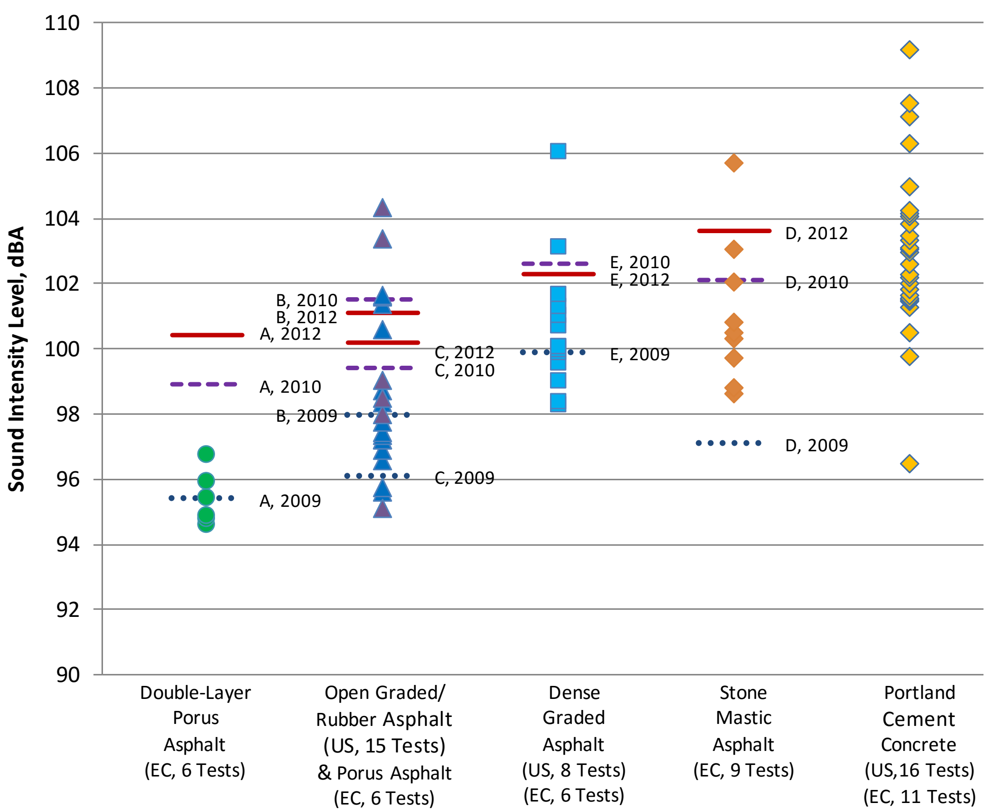

Notes:

- OBSI results for light vehicles, in dBA. Results are shown for five general pavement types.
- Dots are results from Noise Intensity Testing in Europe (NITE) Studies I and II. NITE values are compilation/ comparison of California, Arizona, and European noise measurement results at 60 mph (97 km/h)
- Lines are results from Highway 405 testing for 2009, 2010, and 2012, at 100 km/h. Highway 405 Test Sections are:
  - Test Section A: 30mm OFC, over 50mm HL4 OFC
  - Test Section B: 30mm OFC, over 50mm Superpave 19.0
  - Test Section C: 30mm RAC-O, over 50mm Superpave 19.0
  - Test Section D: 30mm SMA 9.5, over 50mm Superpave 19.0
  - Test Section E: 40mm SP 12.5 FC2, over 50mm Superpave 19.0

Figure 3: Comparison of OBSI Measurement Results with NITE Studies I & II Results