

Questions and Answers About Quieter Pavements

Developed by the Tire-Pavement Noise Research Consortium under TPF-5(135)

What makes some roads quiet and others loud? The answer is not as simple as one might imagine. The intent of this document is to provide answers to some of the more common questions about quieter pavements.

What is a quieter pavement?

Quieter pavement is a relative term for any pavement that produces less noise than another from the action of vehicle tires rolling over it. Many people have experienced living nearby or driving on pavements that are perceived to be loud or quiet. Quieter pavements are not limited to being asphalt or concrete, but rather incorporate known practices to make either quieter. Based on research in the United States and worldwide, it is possible to select,

design, and build pavements that are quieter rather than noisier. The reductions achieved depend on how loud the noisier pavement is relative to the quieter one.

What is traffic noise?

Traffic noise is a combination of all of the sound generated by vehicles as they travel down the road. Broadly speaking, traffic noise is comprised of sound coming from the vehicles' powertrain (engine, exhaust, and other driveline parts), sound from the air as it flows over, under, and around the vehicles, and sound from

the tires rolling on the pavement that we call *tire-pavement noise*. At highway speeds, tire-pavement noise is the largest contributor to the total traffic noise.

Why aren't pavements designed and constructed quieter?

Traditionally, pavements have been designed and built to balance three factors: 1) safety; 2) durability; and 3) cost. Until recently, little was known about how to balance these factors along with the additional goal of making the pavement quieter. Fortunately, improved practices (e.g., controlling variability in pavement surface mixtures and texture) are now known that can be used to design and construct quieter pavements while optimizing safety, durability, and cost.

What about a pavement can make it quiet or loud?

Texture and porosity are the two primary pavement factors affecting tire pavement noise, with texture being the most significant. Texture is characterized by *wavelength*, which can be visualized as the distance

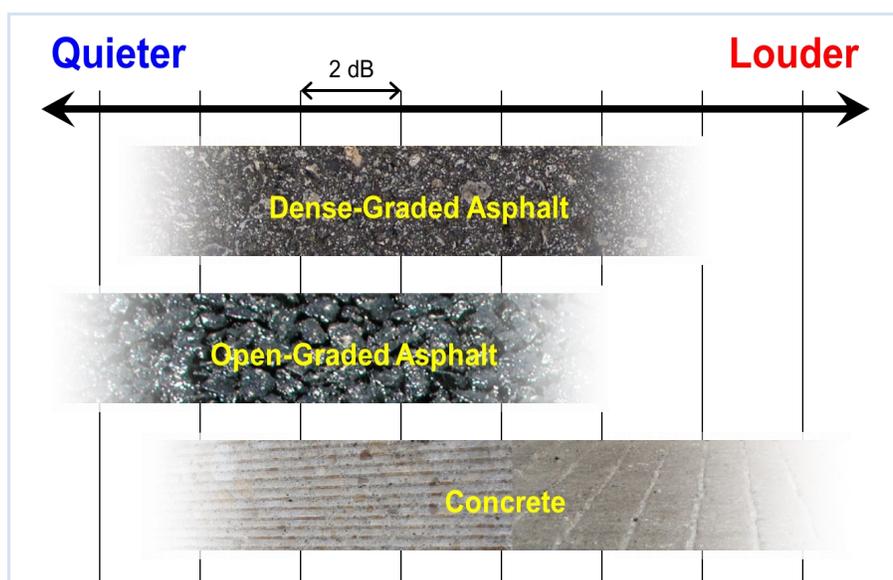


Figure 1. Range of tire-pavement noise levels for various types of pavement.

between alternating peaks and valleys. Generally, texture with a wavelength from one-half to two inches produces the highest noise levels. So, when a pavement has a lot of texture of this size, it can be loud. To reduce the noise, this texture should be “flattened” or negative with respect to the roadway surface (see Figure 2). A perfectly smooth pavement will not work though, as a quieter pavement must have some fine (closely spaced) texture. As a rule, any texture that is present on a quieter pavement will be negatively oriented, meaning it points “down”, away from the tire. Porosity in the surface course of the pavement can also reduce tire-pavement noise. With the texture and all else being equal, a high porosity pavement is likely to be quieter.

How much does the pavement contribute to traffic noise?

Part of the answer depends on the traffic itself. Powertrain and exhaust noise can dominate under stop and

go conditions or speeds under 30 mph. Engine and exhaust can also dominate near intersections, when there are climbing grades, or when other factors cause speed changes. In all these situations, tire-pavement noise may not be the major noise source, so quieter pavements may be less effective at reducing traffic noise. Quieter pavements are most effective at highway speeds with free flowing traffic, when tire-pavement noise is the primary contributor to the total traffic noise.

Can a given quieter pavement alternative be used everywhere?

Local experience has shown that not all quieter pavement strategies can be used in all locations. There is no “one-size-fits all” solution for use of quieter pavements and differences in weather, traffic, cost, and even local expertise can make what seems like a good idea, less than ideal. For example, the aggressive action of snow chains or tire studs can deteriorate some pavement surfaces

that would otherwise perform well in warmer climates. Fortunately, there are quieter pavement alternatives that have been used successfully in many different traffic and weather conditions. Candidate pavements should be identified based on existing knowledge of how various materials have performed in the particular region. If in doubt about the effectiveness of a quieter pavement for a given area, it is recommended that trials be conducted before widespread implementation.

Do pavements get louder with time?

Yes. Given enough time, all pavements will get louder as they deteriorate from traffic and weather. Recognizing how quickly a pavement will become louder is just as important as knowing how quiet it is when new. Some pavements will increase in tire-pavement noise faster than others will. The best choice for a quieter pavement may be one that remains relatively quiet over

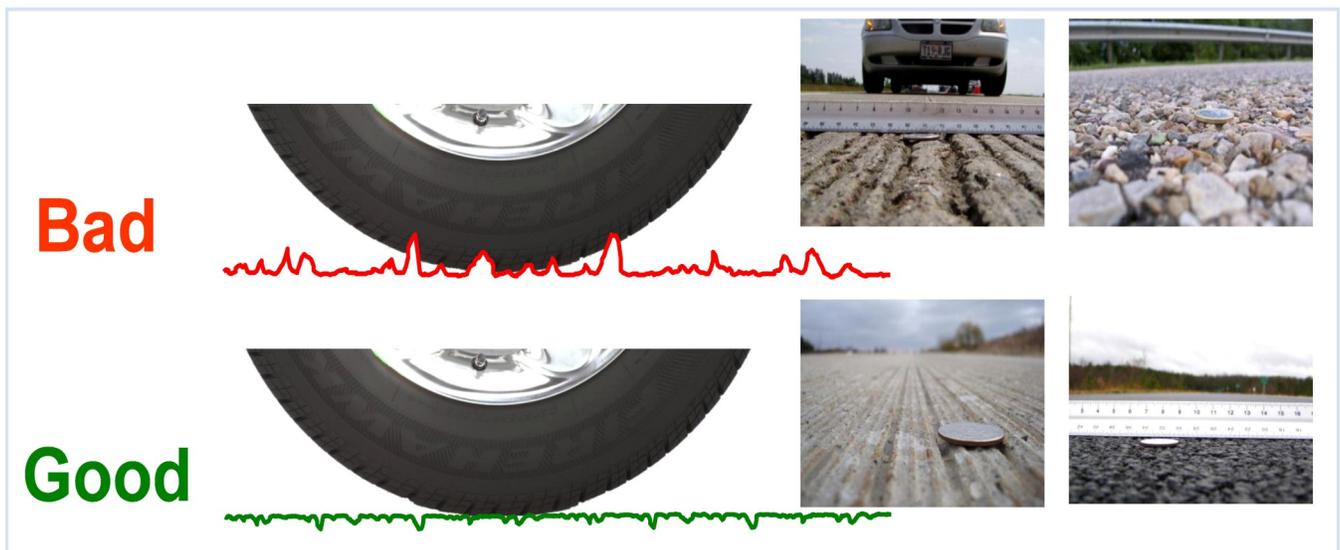


Figure 2. Conceptual schematic and photos of bad and good texture profiles as they relate to tire-pavement noise generation potential.

a long period, even if it is not the absolute quietest pavement when it is first constructed. To understand this phenomenon, a statewide or regional database could be developed to track and rate pavement noise levels over time.

How are sound levels reported? What is a dBA?

Sound levels are reported using units of decibels, abbreviated as dB.

Higher decibel levels are louder.

Figure 3 illustrates some typical noise sources and their sound levels.

It is important to understand that the decibel scale is a logarithmic scale and, as a result, combining sound levels is not simple (arithmetic) addition.

For example, given two individual sound sources of 60 dB, the combined sound level is only 63 dB, not 120 dB. When measuring sound, *A-weighting* is commonly used to adjust sound frequencies in a way to better match the way the human ear hears. *A-weighted* sound levels are reported as dBA or dB(A).

The logarithmic scale also affects how changes in sound level are perceived. Most people will not easily notice when a sound increases 3 dB or less. However, a 5 dB change is readily noticed, while a 10 dB increase is perceived as “twice as loud”.

How is the noise performance of pavements measured?

There are several methods used to quantify pavements for reducing noise. One method is called *on-board*

sound intensity (OBSI) that provides a direct measure of tire-pavement noise. OBSI uses two specialized test probes that use two microphones each. The probes are positioned mere inches from the rolling tire so that they measure the noise coming from where the rubber meets the road. A standard reference tire and constant speed are used so that the measurement can focus on differences in pavements, and not differences in tires or speed.

A second type of measurement uses wayside techniques to quantify the

effect of pavement on reducing overall traffic noise. These use roadside microphones placed 25 or 50 feet from the center of the outside lane. Two techniques in the standardization process are *statistical isolated pass-by* (SIP) method and the *continuous-flow traffic time-integrated* method (CTIM). The advantage of wayside testing is that it is a combined measure of all traffic noise sources and is thus more directly related to the noise levels experienced by people living and working near the highway.

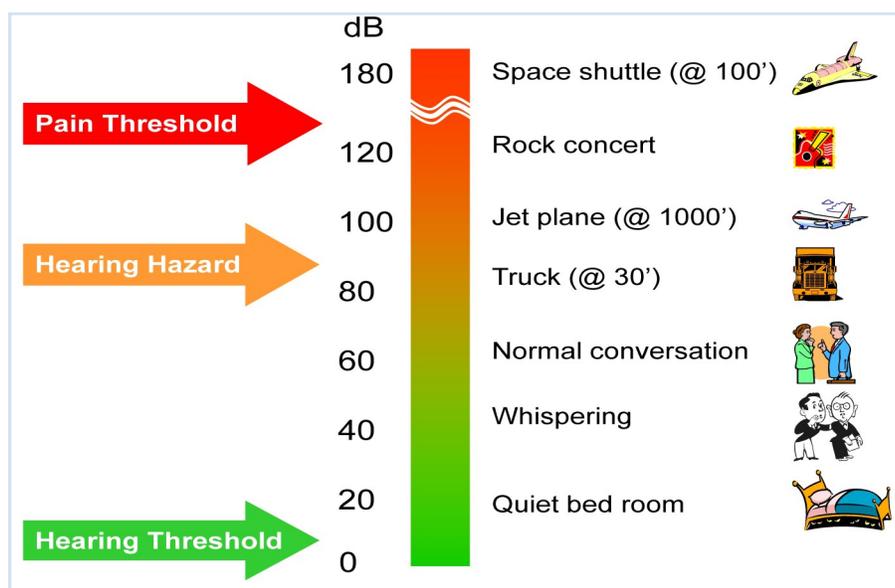


Figure 3. Typical noise sources and corresponding sound levels.



Figure 4. Locations of microphones for measuring tire-pavement noise. (Left: measuring at the source using the OBSI method; right: microphones for wayside measurements)

How does tire-pavement noise reduction compare to noise reduction measured at the roadside?

Since tire-pavement noise is often the most significant contributor to traffic noise, reductions at the noise source should produce some corresponding reductions along the roadside. However, the roadside reductions depend on a few additional factors. For example, when traffic is mostly cars, speeds are greater than 30 mph, and traffic is free flowing, the reduction is almost 1-to-1. In other cases, the roadside noise reduction from a quieter pavement can be diminished because of other noise contributors, such as engine and exhaust noise. This is particularly true when there are many trucks, traffic speeds that are slow or variable, and/or the road is on a grade.

Will quieter pavements help people living far from the road?

If quieter pavements are used successfully, they can reduce the level of the sound generated at the tire-pavement interface. That said, the difference that a quieter

pavement will have to your overall noise environment depends on your location and environmental factors. Traffic noise decreases as distance from the roadway increases. The benefits of any noise abatement method fade at increased distances because, as traffic noise decreases, other sources such as local roadways and residential noises, become more significant. There are many factors affecting how sound travels including temperature, wind, and the varying reflection of sound off different ground types and terrain. Therefore, the distance that a noise abatement method is beneficial must be evaluated or modeled case-by-case considering environmental factors and noise propagation effects.

What else can be done to control traffic noise?

Traditionally, noise barriers have been the most important tool for controlling traffic noise in the community. However, barriers are not the right solution for every location because of roadway geometry, construction feasibility, or an inability to provide significant noise reduction. Federal and state policies have developed a rational approach to determine when to use barriers. Other traffic noise

abatement measures listed in 23 CFR 772 include traffic management, modifying horizontal and vertical roadway alignments, and purchasing roadside property to create a buffer zone. Another important tool is the encouragement of community planning that separates homes from busy roads. It must be recognized that any solution for controlling traffic noise—including the use of quieter pavements—will have both benefits and limitations.

How does the use of quieter pavement fit in with other noise abatement measures?

Pavement type is currently not recognized under 23 CFR 772 as a factor in reducing traffic noise. As a result, quieter pavement is not allowed as a noise abatement method in federally funded projects. However, the use of specific pavement types in determination of noise impacts is planned for future implementation. In the meantime, state highway agencies can benefit from understanding quieter pavements today as an option to enhance their other abatement measures, and from the perspective of potential future policy requirements.

About TPF-5(135)

This brochure is produced and published under Transportation Pooled Fund project number TPF-5(135), “Tire-Pavement Noise Research Consortium”. The objective of the pooled fund project is to combine the resources and expertise of federal and state agencies along with industry to perform tire-pavement noise research and technology transfer. The lead agency for project TPF-5(135) is the Washington State Department of Transportation. Sponsoring partners are the Departments of Transportation in the states CA, CO, KS, MN, MT, NC, OH, TX, and WA, along with the Federal Highway Administration.

For more information about tire-pavement noise and quieter pavements in your state, please contact the noise specialist within your state highway agency.

How can I learn more?

Tire-Pavement Noise:

- Robert O. Rasmussen, et al., “The Little Book of Quieter Pavements”, Report FHWA-IF-08-004, USDOT Federal Highway Administration, 2007, <http://www.tcpsc.com/LittleBookQuieterPavements.pdf>
- Ulf Sandberg and J. Ejsmont, “Tyre/Road Noise Reference Book”, Informex, Handelsbolag, Sweden, 2002.

Policy Guidance:

- United States Code of Federal Regulations, 23 CFR 772, “Procedures for Abatement of Highway Traffic Noise and Construction Noise”, Federal Register, Vol. 75, No. 133, 13 July 2010.
- Federal Highway Administration, Tire-Pavement Noise Website: http://www.fhwa.dot.gov/environment/noise/tire_pavement_noise
- California Department of Transportation (Caltrans), Pavement Policy Bulletin, “Quieter Pavement Strategies for Noise Sensitive Areas”, 2009. <http://www.dot.ca.gov/hq/esc/Translab/ope/QP-Memo-&-Bulletin-Oct-15-09.pdf>

Measurements:

- Paul Donovan and Dana Lodico, “Measuring Tire-Pavement Noise at the Source”, National Cooperative Highway Research Program Report 630, 2009.
- American Association of State Highway and Transportation Officials, “Standard Method of Test for Measurement of Tire/Pavement Noise using the On-Board Sound Intensity (OBSI) Method”, AASHTO Specification TP 76-10, 2010.
- American Association of State Highway and Transportation Officials, “Standard Method of Test for Determining the Influence of Road Surfaces on Traffic Noise Using the Continuous-Flow Traffic Time-Integrated Method (CTIM)”, Proposed AASHTO Provisional Specification.
- American Association of State Highway and Transportation Officials, “Standard Method of Test for Determining the Influence of Road Surfaces on Vehicle Noise Using the Statistical Isolated Pass-By Method (SIP)”, Proposed AASHTO Provisional Specification.
- Fleming, Gregg G., A. Rapoza, C. Lee. “Development of National Reference Energy Mean Emission Levels for the FHWA Traffic Noise Model”, Report No. FHWA-PD-96-008 and DOT-VNTSC-96-2, Cambridge MA: John A. Volpe National Transportation Systems Center, Acoustics Facility, November 1995.

Materials and Construction:

- Robert O. Rasmussen, et al., “How to Reduce Tire-Pavement Noise: Better Practices for Constructing and Texturing Concrete Pavement Surface”, National Concrete Pavement Technology Center, 2011.
- André de Fortier Smit, NCAT Report 08-01, “Synthesis of NCAT Low-Noise HMA Studies”, National Center for Asphalt Technology, 2008.
- Washington State Department of Transportation (WSDOT) Quieter Pavement Evaluation Site: <http://www.wsdot.wa.gov/Business/materialslab/quieterpavement>
- California Department of Transportation (Caltrans) Quieter Pavements Site: <http://www.dot.ca.gov/hq/esc/Translab/ope/QuieterPavements.html>