Roadway Noise Basics

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Figure 1: Wayside Measurements Measure Total Traffic Noise

>>> NOISE BASICS

Highway noise is the result of vehicular travel along a roadway. It is a function of the volume and speed of the traffic. It consists of all the noise produced by each vehicle's drivetrain, exhaust, tires, air turbulence, as well as other design features such as horns and braking operations.

For typical highway applications, the noise contribution of cars and large trucks is quite different. Passenger cars for example, generate about 70 to 90 percent of their total noise through the tire-pavement interaction. This fact implies that modification of the roadway surface and/or the tire type can meaningfully impact the overall tire-pavement noise.

Large trucks contribute to noise in a much different way than cars, and this should always be considered. Although trucks have similar types of noise sources, the magnitude and location of these sources is quite different. Truck tires also interact with pavement differently than car tires and generally the surface texture does not have a significant effect on the tire-pavement noise level. This suggests that where there is a higher percentage of trucks, less tire noise reduction can be gained through pavement surface types.

As noise travels away from its source, it decreases in overall loudness. Typically, for highway applications, noise is reduced by 3 dBA for each doubling of the distance. So, if it were 70 dBA at 50 feet from the roadway, it would be 67 dBA 100 feet away. For typical highway design, it is common to prevent the surrounding properties from achieving noise levels of 67 dBA or higher.

Another important fact about noise is that if you double the traffic, you increase the overall noise level by 3 dBA. If the existing traffic produced a noise level of 64 dBA within the neighborhood, doubling the same traffic would increase it to 67 dBA. Reducing the traffic by half also reduces the total noise level by 3 dBA.

When evaluating noise levels, remember that a 3 dBA difference is considered a barely perceptible change by the FHWA, as indicated in the Table. A 10 dBA change is a doubling of the noise that is heard by the ear. A 5 dBA change is considered a substantial change. Note that, as mentioned previously, doubling of the traffic volume results in only a 3 dBA change, whereas a 10 dBA difference is necessary to double the noise level that is heard. This peculiarity is a function of how logarithms work and how noise is analyzed.

>>> FACTORS AFFECTING TRANSPORTATION NOISE

For highways, noise mitigation is concerned with protecting the surrounding properties from excess levels of noise. This can be accomplished

Figure 2: On-Board Sound Intensity Measurement (Measures only Tire Pavement Noise)

TABLE 1: CHANGES IN DECIBEL LEVELS AND ENERGY LEVELS

DECIBEL CHANGES, LOUDNESS AND ENERGY LOSS

Sound Level Change	Relative Loudness	Acoustic Energy Loss
0 dBA	Reference	0
-3 dBA	Barely Perceptible Change	50%
-5 dBA	dBA Readily Perceptible Change	67%
-10 dBA	Half as Loud	90%
-20 dBA	1/4 as Loud	99%
-30 dBA	1/8 as Loud	99.9%

by three different methods: (1) distance, (2) installation of berms or walls, or (3) controlling the noise source (e.g. volume, speed, surface type, exhausts, etc.).

In recent times, there has been more interest in controlling noise at the source by selection of pavement type. This can only be effective when passenger cars comprise the traffic stream and traveling at highway speeds. However, if large trucks are present, it only takes between 4-20 percent heavy trucks for the trucks to become the dominant noise source and hence the pavement solution would not be as effective. Similarly, if speeds are low, then pavement surface is not an effective solution.

Noise regulation is concerned with the amount of noise that impacts surrounding neighborhoods. This is an important concept to remember as the regulation is not concerned with the noise that occurs within an automobile. However, the consumer's perception of roadway noise is often developed from their driving experience and not from their experience living alongside the highway.

>>> HOW NOISE IS MEASURED

The two most common forms of noise measurement in the U.S. consist of wayside measurements and On-Board Sound Intensity (e.g. OBSI) measurements. Wayside measurements, shown in Figure 1, consist of placing a microphone alongside a highway and measuring the total noise that reaches a given point. Although Figure 1 indicates a wayside measurement point approximately 50 feet from the roadway, a more typical location would be a microphone set up in an adjacent property since that is the noise of concern. The wayside measurement includes all highway related noise and, as such, is the best indicator of what is happening in the neighborhood.

OBSI measurements, on the other hand, measure only tire-pavement noise as indicated in Figure 2 and do not include drivetrain, exhaust, and other noise sources. OBSI measurements are useful for determining the effect of pavement surface on noise levels and for evaluating how pavement properties change over time. The basis for this test method is the assumption that the traffic fleet can be represented by a single tire. Since this is a tenuous assertion, this type of measurement is generally used for ranking pavements and determining how the pavement noise characteristics change over time. It should be recognized that the reported value is a function of the tire type and that by changing tires, a different value would be reported. AASHTO currently specifies an ASTM Standard Reference Test Tire (e.g. SRTT) to conduct this work.

>>> WHAT IS A QUIET PAVEMENT?

NCHRP report 634 defines pavement noise levels as indicated in Table 2. Using these criteria would suggest a quiet pavement would be considered 102 dBA or less. However, it should be noted the classifications are separated by only 2 dBA when perhaps a 3 dBA separation would have corresponded better with the barely perceptible change indicated in Table 1.

For roadways where tire/pavement noise is an issue, diamond ground surfaces are the solution of choice for producing quiet concrete pavements. This can be accomplished using conventional diamond grinding techniques or the Next Generation Concrete Surface (NGCS), which is the quietest non-porous concrete pavement surface available. To learn more about these low noise solutions contact the IGGA at www.igga.net.

TABLE 2: NCHRP 634 PAVEMENT NOISE LEVEL CLASSIFICATIONS

Noise Level (OBSI–DBA)	
Low	<102
Fairly Low	102 to 104
Moderate	104 to 106
Fairly High	106 to 108
High	>110

ABOUT IGGA

The International Grooving & Grinding Association (IGGA) is a non-profit trade association founded in 1972 by a group of dedicated industry professionals committed to the development of the diamond grinding and grooving process for surfaces constructed with Portland cement concrete and asphalt. In 1995, the IGGA joined in affiliation with the American Concrete Pavement Association (ACPA) to form what is now referred to as the Concrete Pavement Preservation Partnership (IGGA/ACPA CP3). The IGGA/ACPA CP3 now serves as the lead industry representative and technical resource in the development and marketing of optimized pavement surfaces, concrete pavement restoration and pavement preservation around the world.