You See It! What is It?
Highway Sound Barriers

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Abstract

Engineering is an empirical science and often much of an art. Discovery and the innovation that follows the discovery most often come about through experimentation and trial and error. I imagine Newton was hit on the head with the apple before he came up with the concept of gravity. The theoretical or analytical explanation of most physical phenomena follows the empirical observations of the phenomena. This paper presents a simple experiment that illustrates the way in which the barrier walls that we see everyday, on so many urban highways, buffer the abutting properties from the vehicular noise.

With the exception of a sound level meter, this experiment requires no special equipment. The students learn how to collect and plot data using Excel. They compare their results to actual road results using data from the Internet. This is an experiment that can be used in an introductory course in engineering and may also be used in courses intended to introduce students to experimentation. In addition, the experiment introduces students to the use of models and environmental issues (sound pollution). It deals with an engineering project that virtually everyone has seen and it lets them experience the relationship between a real world project and the science and engineering behind it. The experiment is ideally suited for a group or team effort.

Introduction

Roadside sound barriers were selected as a hands-on experiment for freshmen engineering students because it was something that virtually all students had seen yet not all were aware of their intent. In a humorous note, some adults (of the conspiratorial nature) thought they were to confine people. Of course engineers, especially civil engineers know that these barriers are to reduce the intrusion of vehicular noise from highways into the abutting residential neighborhoods. Another reason for selecting this experiment was that it could easily be modeled in the classroom with minimal equipment. The only piece of scientific instrumentation necessary was a sound meter, which can be purchased for under $50 or slightly more for a more precise model. However, this is not necessary since the study of the effectiveness of a barrier depends only on relative sound levels. Figure 1 shows a schematic of the test set-up.

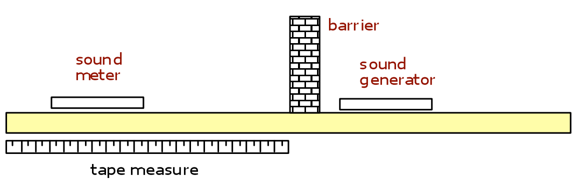

Figure 1 experimental Set-Up

Any random noise generator may be used to simulate the road noise but a simple AM/FM radio will serve very well. Setting the radio to a frequency with static only provides adequate simulation of vehicle sound. We constructed sound barriers using common materials such as brick, cardboard, foam, cork, etc. Our experiments were run in a computer laboratory so that the students could immediately process their data on computers (Photo 1).

Photo1. Laboratory Set Up

The experimental procedure may be summarized as follows:

1- First sound level readings were taken with no barrier to establish the ambient noise level.

2- The sound source is tuned to maximum level of irritation (radio frequency with no station) and the decay of the sound is measured and recorded as the sound-meter is moved away from the source. This represents the sound level at various distances from the source with no attenuation (see chart 1). You will notice the random nature of the plotted data. The students discussed the possible reasons for the fluctuations of the level of sound and examined trend lines for this data to compare the experimental data with what would be the theoretical decay of sound with distance. This aspect of the experiment is not part of this presentation.

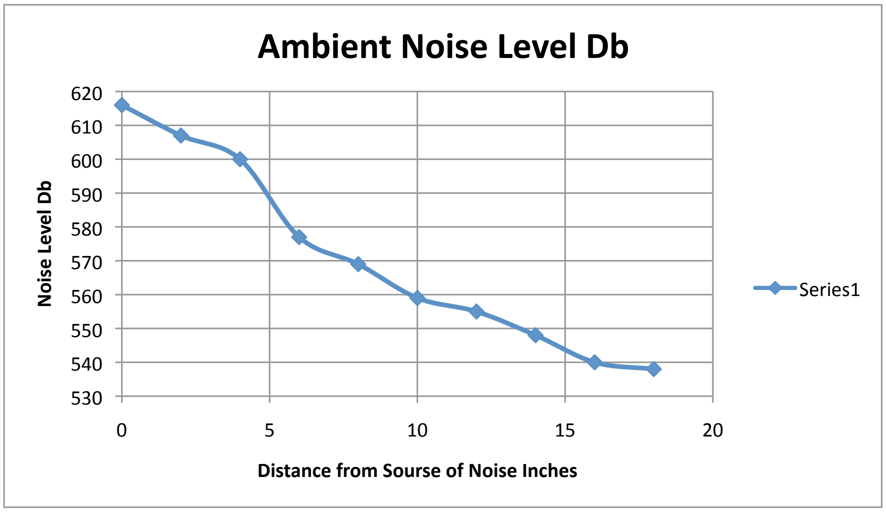

Chart 1 Attenuation of sound without a barrier

3- The experiment is repeated with various barriers made of selected materials such as brick, cardboard, cork, etc. (see Photo 5 and Chart 2). List the noise level without a barrier (NL no B, column 2) and with a barrier (NL w/ B, column 3) and the % reduction in noise level (% R in NL, column 5) as you move away from the barrier.

Col. 1 D from B inches	Col. 2 N NL no B Db	Col. 3 NL w/B Db	Col.4 Red in NL	Col.5 % R in NL
0	616	108	508	82%
2	607	98	509	84%
4	600	95	505	84%
6	577	93	484	84%
8	569	92	477	84%
10	559	90	469	84%
12	555	89	467	84%
14	548	88	460	84%
16	540	88	452	84%
18	538	87	451	84%

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Comment: What is column 4?

Chart 2 Reduction in Noise level

4- Finally all collected data are plotted on an Excel spreadsheet. The students then were asked to determine the effectiveness of various materials and the effect of distance from the barrier on the attenuation of noise. In addition the students were also asked to do research using the world-wide-web about the effectiveness of actual sound barriers built along highways. For an advance project the similitude associated with modeling may be considered, but it was not in this elementary exercise.

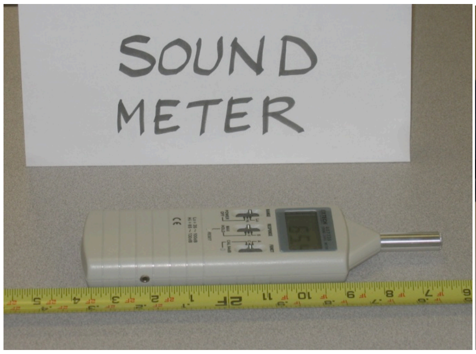

Photo 2 Sound Meter

Photo 3 Back Side of Barrier

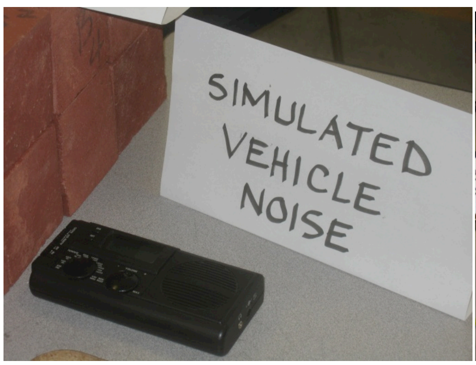

Photo 4 Radio (Simulated Road Noise)

Photo 5 Various Barrier Materials

Selected Photos

Photo 5 shows the construction of a sound barrier on an interstate highway.

Photo 6 shows a concrete sound barrier wall that has been cast with scenic decorations to enhance the appearance of the wall.

Photo 7 is a schematic diagram illustrating the use of shrubs and trees, which not only improve the appearance of the site but also enhance the attenuation of sound through the use of foliage.

Photo 8 illustrates a typical installation of an elementary sound barrier along a rural highway.


Photo 5 Road to the Future 2007


Photo 6 Portland Cement Associatio

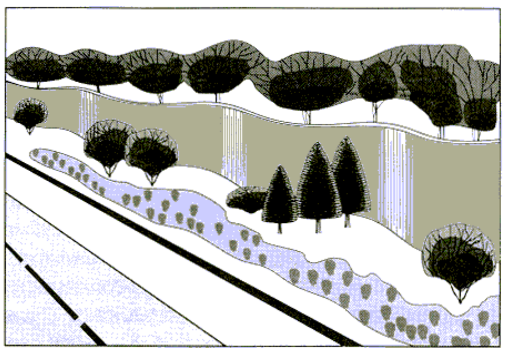
Photo 7 Howard County, MD PD


Photo 8 Advanced Forming Technology

Conclusion

This simple experimental analysis of the attenuation of sound through the use of barriers erected between highways and abutting residential communities is particularly useful to introduce students, both pre-college and freshmen engineering students to concepts of laboratory experimentation. At this level a very perfunctory concept of noise abatement is introduced. When used at the college level the students may be introduced to more advanced highway noise abatement concepts that for civil engineering students would be taught in advanced transportation engineering courses. At this elementary introduction the nuances of similitude that affect the scale of the experiment are ignored. As well as the influence of the slope of terrain behind the barrier wall. As slope rises behind the wall the effect of sound may be increased at distances from the wall. This would be an appropriate part of an advanced course in transportation engineering.