Traffic Noise Barrier Overlap Gap Study

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Abstract: Sound propagation through the gap produced by two parallel vertical barriers with overlapped ends was formulated for traffic noise sources. Six receiver regions were considered based on potential receiver locations with respect to a gap. The analysis identified both source and receiver regions according to the mechanisms which influence noise propagation in the vicinity of an overlap gap which can result in: direct rays, diffracted rays from the top edge of one barrier, diffracted rays from the top edge of both barriers, rays reflected between the barriers and rays that are both reflected and diffracted. The results of using equations approved by the United States Federal Highway Administration (FHWA) for traffic noise propagation are given. Field measurements for up to 30 receiver positions from four overlap gaps were compared with uncalibrated predictions. The equivalent continuous levels, A-weighted, were overpredicted by 2-3 dB.

INTRODUCTION

Ideally, noise barriers would have no discontinuities at all. However, few barriers can be designed without the need arising for a break in the wall. Breaks in noise barriers are needed for many reasons: maintenance, safety access, drainage, and barrier transitions between different roadway sections. When these breaks are necessary, overlap gaps are often used to lessen the effect of the discontinuity.

At a particular noise barrier site located in southwestern Ohio, north of Cincinnati on Interstate 71, a total of 12 overlap gaps have been incorporated into the barrier's design. A preliminary investigation of these noise barriers showed that overlap gaps contributed to the degradation of the barrier insertion loss. It was hypothesized that multiple reflections were the primary reason that the insertion loss degradation was occurring. A study was initiated to both evaluate the hypothesis and to develop a tool to improve the design process for overlap gaps.

OBJECTIVES

The objectives of the study were:

1. Identify the factors that currently degrade barrier performance in gap areas.
2. Develop an acoustical model to predict noise propagation through barrier gaps.
3. Perform sound pressure level measurements to characterize the acoustical sound field in overlap gap areas.
4. Validate the acoustical model using data acquired from field measurements.

GAP GEOMETRY AND PROPAGATION PATHS

A typical overlap gap configuration is represented in Figure 1. The traffic noise source is taken to be the center of each vehicle travel lane present for a given site. Receivers can be located within the gap or more typically on the opposite side of one of the barriers from the source. A number of simplifications, assumptions, and / or limitations were used in the development of the model. All barriers must be parallel to the line of the noise source. Reflections were assumed to be specular. Ground reflections are not included, and the ground at all sites is assumed to be acoustically hard. Further, the effect of diffraction for noise flanking the ends of a barrier is not included. The possible paths through which noise may propagate to a receiver at an overlap gap site are: direct propagation, simple diffraction, double diffraction, multiple reflected rays (MRR) multiple reflected diffracted rays (MRDR).
From the possible paths identified above, six receiver cases were defined according to the location of the receiver. For a given receiver case, the possible paths were further subdivided to determine which source regions yield the various paths. Image ray analysis was then used to develop the geometrical relationships needed to calculate the total path distance from source to receiver for each possible path, and to determine the location of any reflections. The source roadway was then divided into finite segments in order to approximate the initial point of propagation for each ray. In order to calculate the final predicted noise level at a given receiver, both the initial source energy and the equations of propagation which account for the various attenuation mechanisms to be considered (such as geometric divergence, atmospheric absorption, barrier attenuation, etc.) must be implemented for each possible path.

**COMPARISON WITH FIELD MEASUREMENTS**

The derived method could be implemented using various equations for sound propagation. The results of using equations approved by the United States Federal Highway Administration (FHWA) for traffic noise propagation were compared with field measurements. Levels measured for up to 30 receiver positions from each of four overlap gaps were compared with uncalibrated predictions.

For all sites taken as a whole, the equivalent continuous levels, A-weighted, were overpredicted by 2-3 dB.

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