TRAFFIC NOISE PROPAGATION THROUGH FOUR VANCOUVER LANEWAYS

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1 INTRODUCTION

The changing built environment of Vancouver's residential laneways towards increasing density, such as by infill with laneway housing, has acoustical consequences for laneway home residents. The small dimensions of laneways and increase of reflective surfaces within them contribute to the urban canyon effect—limited geometrical spreading and reduced sound decay inside a laneway relative to open terrain [1, 2]. A study showed that Vancouver laneways near noisy roads exceeded outdoor residential noise limits by 10dB [2]. For laneways exposed to excessive noise, the canyon effect exacerbates noise conditions by keeping noise levels high further into the laneway.

The physical form and environmental characteristics of residential laneways were investigated in terms of reflectivity and absorptivity, which affect sound attenuation. Factors taken into consideration included degree of vegetation, surface textures, ratio of reflective building surfaces, laneway dimensions, and ground conditions. It was hypothesized that the more reflective a laneway is—typically achieved by laneway pavement and larger buildings along the lane—the more it would behave like an urban canyon. An empirical test method and two modelling methods were used to test the hypothesis.

2 METHOD

Four case study Vancouver laneways were investigated for physical characteristics that affected sound propagation (see Figure 1). These were quantified in terms of overall reflectivity. A was a new development laneway estimated to have 90% reflective material surfaces. B was a high-density mixed commercial laneway estimated to have 80% reflective material surfaces. C was an older regular laneway estimated to have 60% reflective material surfaces, and D was a highly-vegetated, low density and unpaved laneway estimated to have 35% reflective material surfaces.

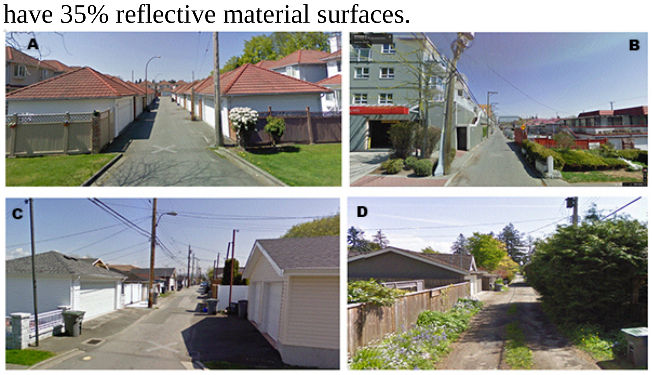

Figure 1: Four case study laneways in Vancouver, B.C.

Sound propagation was measured in SPL (dBA) at increments of 10m along each case study laneway, in the direction away from a stationary point source emitting pink noise from one end of the laneway. Attenuation describes the decrease in measured SPL from the source level. Each laneway's attenuation trend described its unique capacity to absorb sound. The laneway sound decay trends were compared to the standard traffic noise model for theoretical hemispherical sound decay over an open, unobstructed area, with adjustments for terrain type [2, 3, 4]. Figure 2 shows the theoretical curves as reference trends for point source sound propagation over open area.

Odeon software and CMHC were used to model sound propagation through each case study laneway. Point source propagation data modelled in Odeon was compared to empirical data. CMHC predicted traffic noise levels based on line source sound propagation theory [4]. In this application, the laneways were modelled using one perpendicular road for line source. The modelling tools were assessed for laneway application.

3 RESULTS

3.1 Empirical results of point source decay

Figure 2 shows that SPL attenuation through at least the first 95m of all laneways was lower than that in an open area, differing by as much as 15±1dBA for reflective A and B. However, beyond 95m, absorptive D exhibited higher attenuation than open area by up to 6±1dBA. A and B were 13.8±1dBA louder than D at 75m (about six houses down the block), and B was 19.3±1dBA louder than D at 130m. For reference on perceived loudness, 3dB is a noticeable difference, 6dB is a substantial difference, 10dB is double the perceived loudness and 20dB is quadruple the perceived loudness [5].

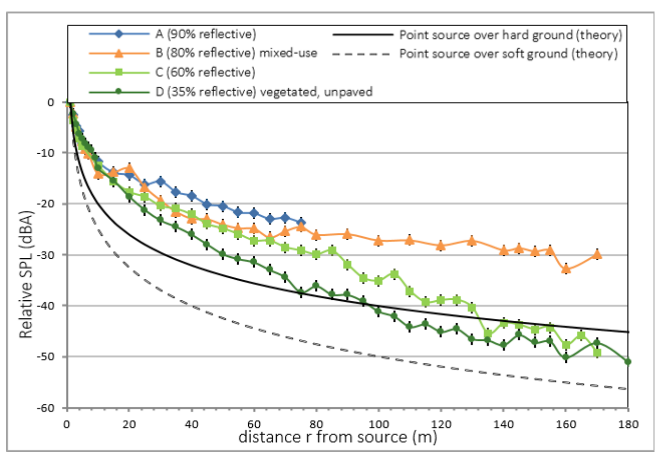

Figure 2: Point source sound attenuation through laneways, empirical data

3.2 Odeon model for point source decay

Point source Odeon model data was calibrated for the near field effect (based on empirical data) and compared to empirical data. Figure 3 shows that at r > 80m, empirical data better demonstrated the effects of reflections (e.g. laneway B) and absorption (e.g. laneway D) than Odeon data, with a discrepancy reaching 9±1dBA. At 75m, Odeon predicted B to be 7.5±1dBA louder than D where empirical data was 13.8±1dBA louder.

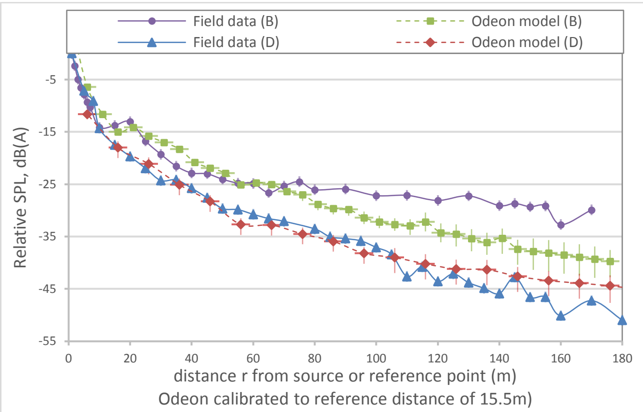

Figure 3: B and D point source attenuation; empirical data vs. Odeon model data

3.3 CMHC model for line source decay

Figure 4 shows CMHC line source attenuation model results. The more reflective cases A, B and C attenuated similarly to one another: roughly 2±1dBA more than CMHC's reference line source decay trend over open hard ground and up to 4±1dBA less than point source decay over open hard ground. Significant discrepancy was predicted between the reflective cases and the absorptive case D. At 75m, A was 9±1dBA louder than D and B and C were 7±1dBA louder. At 93m, A, B and C were 9±1dBA louder than D. D even attenuated more than the reference line source decay trend over soft absorptive ground, by up to 2±1dBA.

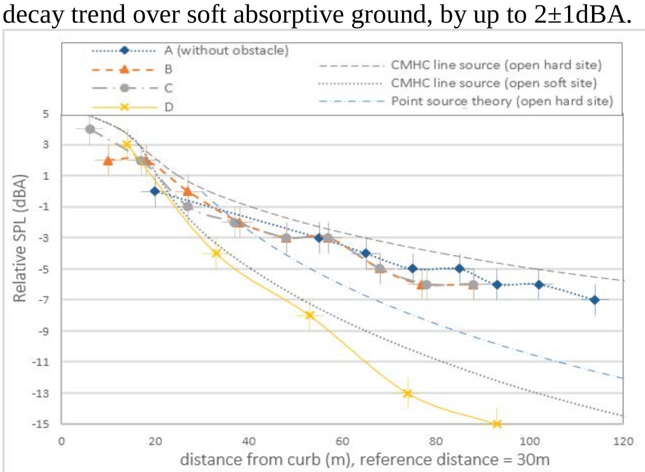

Figure 4: CMHC single line source attenuation results

4 Discussion

Empirical point source propagation results confirmed the hypothesis that the four case study laneways exhibited urban canyon effects. Even the least reflective, most absorptive laneway D maintained notably higher SPL than open field theory for the first 95m. The four case studies demonstrated an inverse correlation between surface reflectivity and sound attenuation through a laneway. All methods showed that high absorptivity could reverse the urban canyon effect, as D began to decay more than open field beyond 95m in empirical data, and beyond 50m in the CMHC model. The most reflective lane was measured to be as much as four times louder than the most absorptive lane.

Odeon adequately modelled the more absorptive cases C and D, but did not satisfactorily predict urban canyon effects in reflective cases A and B. CMHC conservatively estimated the three more reflective laneways to be minimally attenuating and that D was the most effective at noise-attenuation. Both models underestimated the magnitude of SPL discrepancy between B and D at 75m by half of the measured data (7dB vs 14dB).

5 Conclusion

This study confirmed that Vancouver laneways exhibited urban canyon effects, with a positive correlation between laneway surface reflectivity and SPL resulting from sound propagating over distance through a laneway. This is a concern particularly at locations exposed to excessive noise and with increasing laneway construction that increases reflectivity. Vancouver's current laneway housing design guidelines do not specify acoustical requirements [2]. This study shows the need for acoustically designed laneways and laneway housing to provide adequate acoustical protection for residents.

Some acoustical design strategies can be learned from the highly absorptive laneway D, where the canyon effect diminished significantly and eventually reversed with distance. Since the high absorptivity of D was attributed to unpaved dirt road; open yard spaces; shorter, smaller and rougher-surfaced buildings along the laneway; and dense vegetation, these factors can be incorporated as "noise-regulating" design solutions for a quieter laneway living environment. Absorptive and scattering materials such as living walls and green fences, and porous ground cover such as rubber, gravel, dirt or grass, will help attenuate noise through laneways while being space-efficient and beautiful.

Based on the results of this study, both modelling tools required improvement for better prediction of laneway noise levels.

References

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