



Evaluation of Sinusoidal Rumble Strip Noise Levels



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Abstract

Studies have shown that rumble strips installed on a roadway significantly reduce the number of accidents caused by lane departures. However, when a vehicle engages the strips a loud exterior noise is generated in addition to the alerting in-cabin noise. The extraneous exterior noise is capable of traveling at least several hundred feet at a volume which is considered a nuisance by nearby residents. As a result, alternative sinusoidal based designs have been proposed.

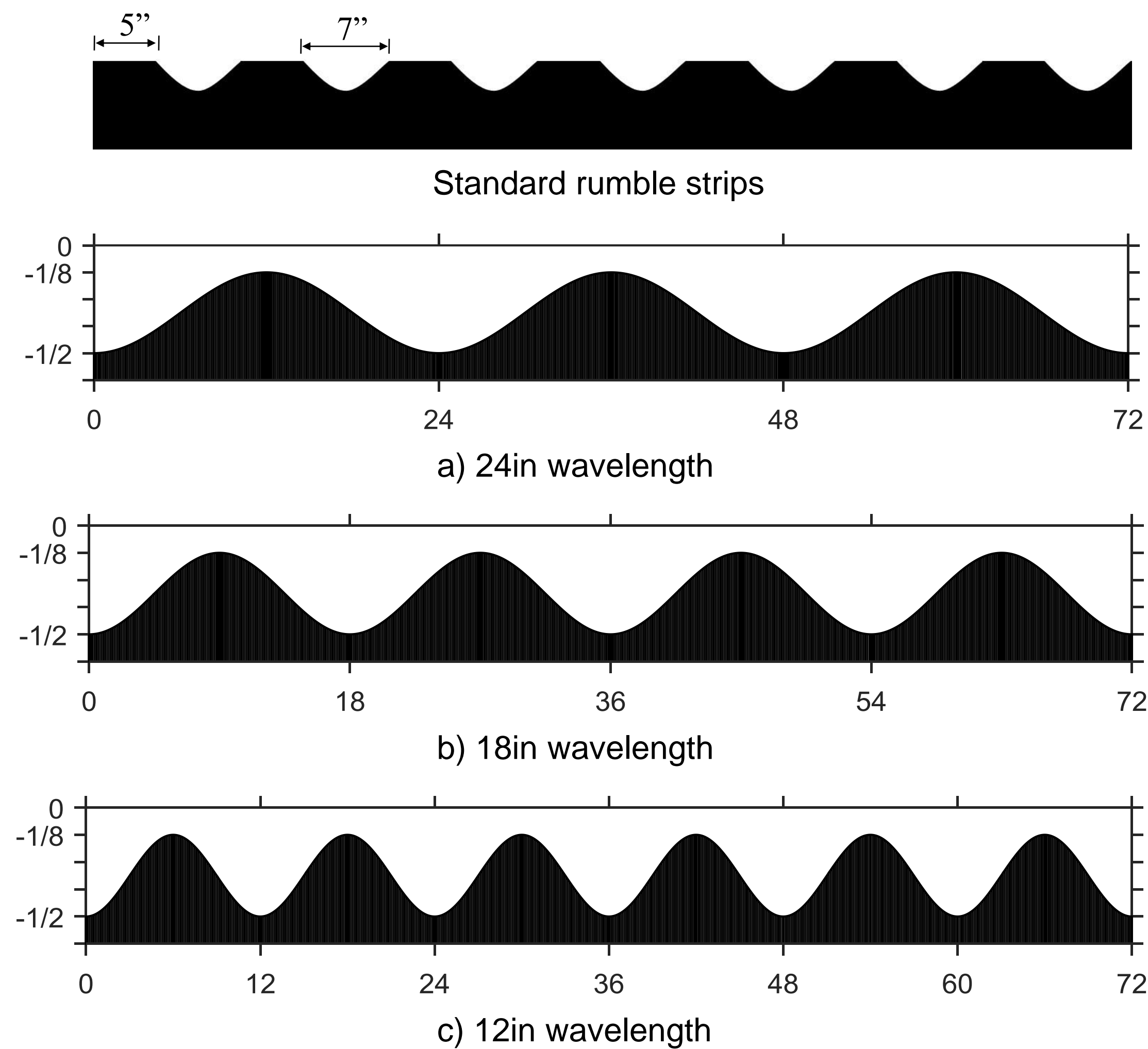
This work studies the sound and vibration of six different vehicles at 50mph on sinusoidal rumble strip incursions at three different wavelengths (12, 18, and 24 inch). For comparison purposes, sound and vibration measurements were made on traditional (standard) rumble strips. The experiment confirms that sinusoidal rumble strips are between 2 and 6 dBA quieter on the exterior of the vehicle. The sinusoidal rumble strips are almost as loud as the standard rumbles on the interior of the vehicle, but still increase the in-cabin sound level by between 2 and 9 dBA as compared to no incursion and are within the residential land use alerting guidelines set forth by NCHRP.

Study Motivation

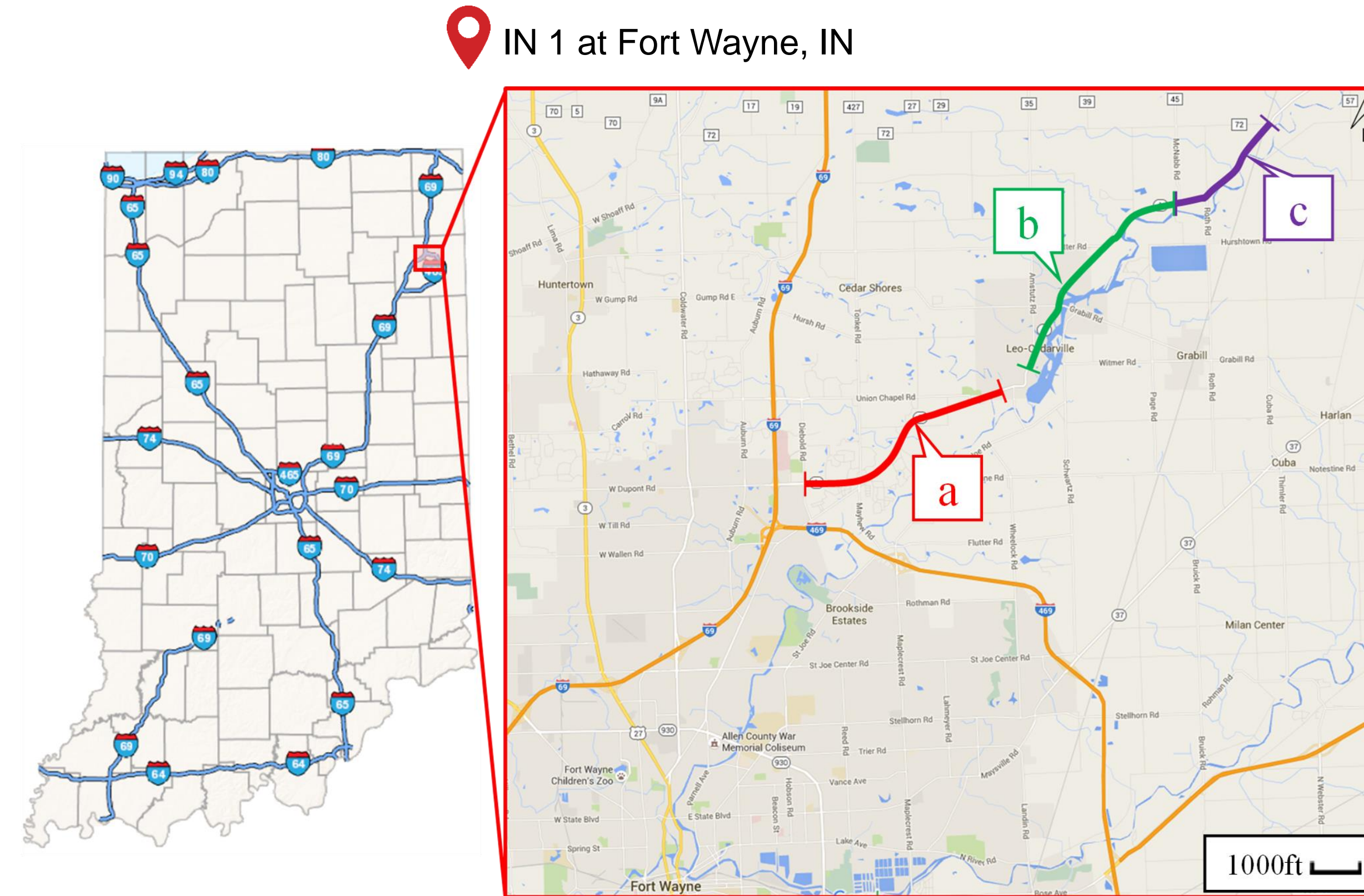


Sinusoidal rumble strips significantly reduce exterior noise compared to traditional square designs. However, it is not known which sinusoidal wavelength provides the best ratio of exterior noise volume and ability to alert a driver departing from their lane.

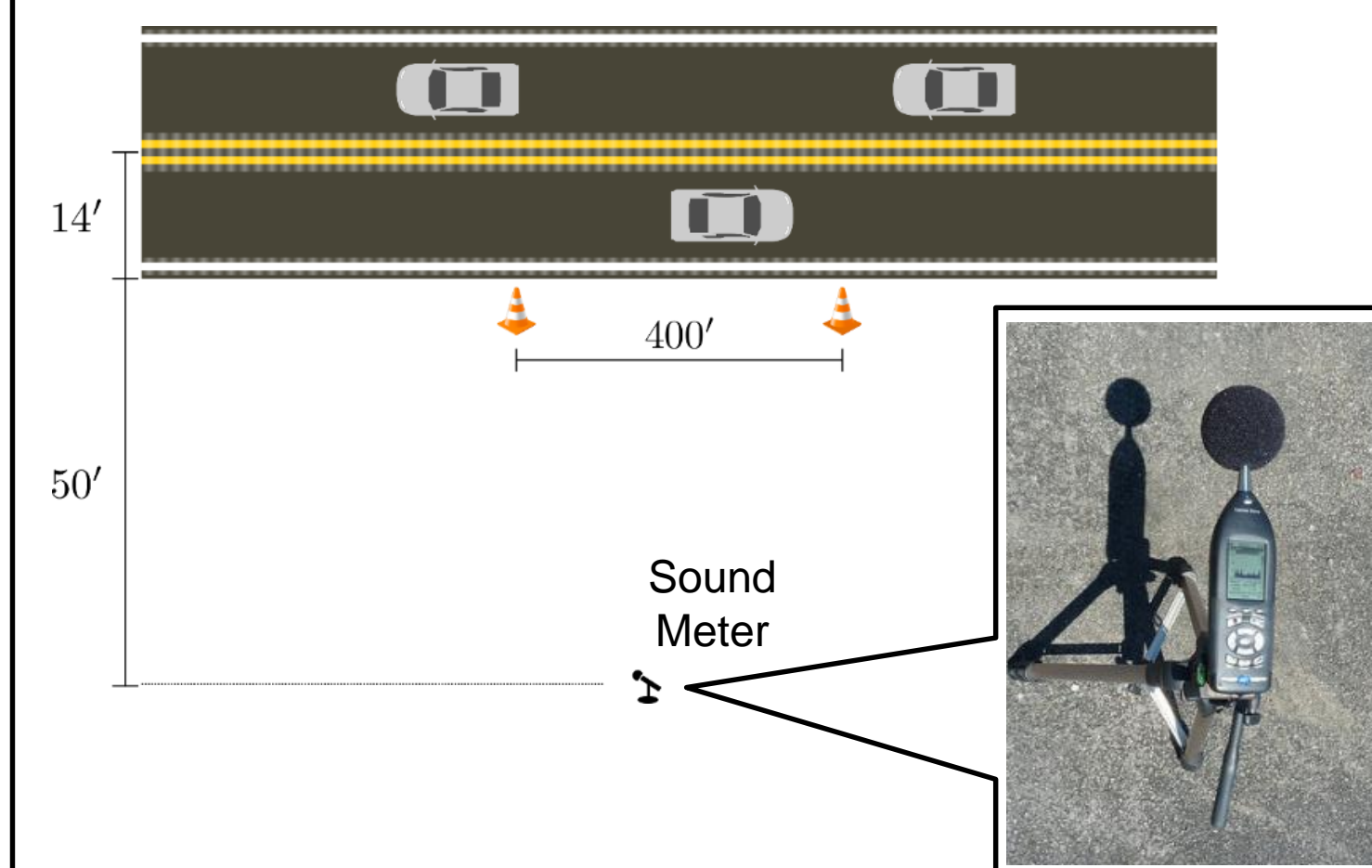
Rumble Strip Designs



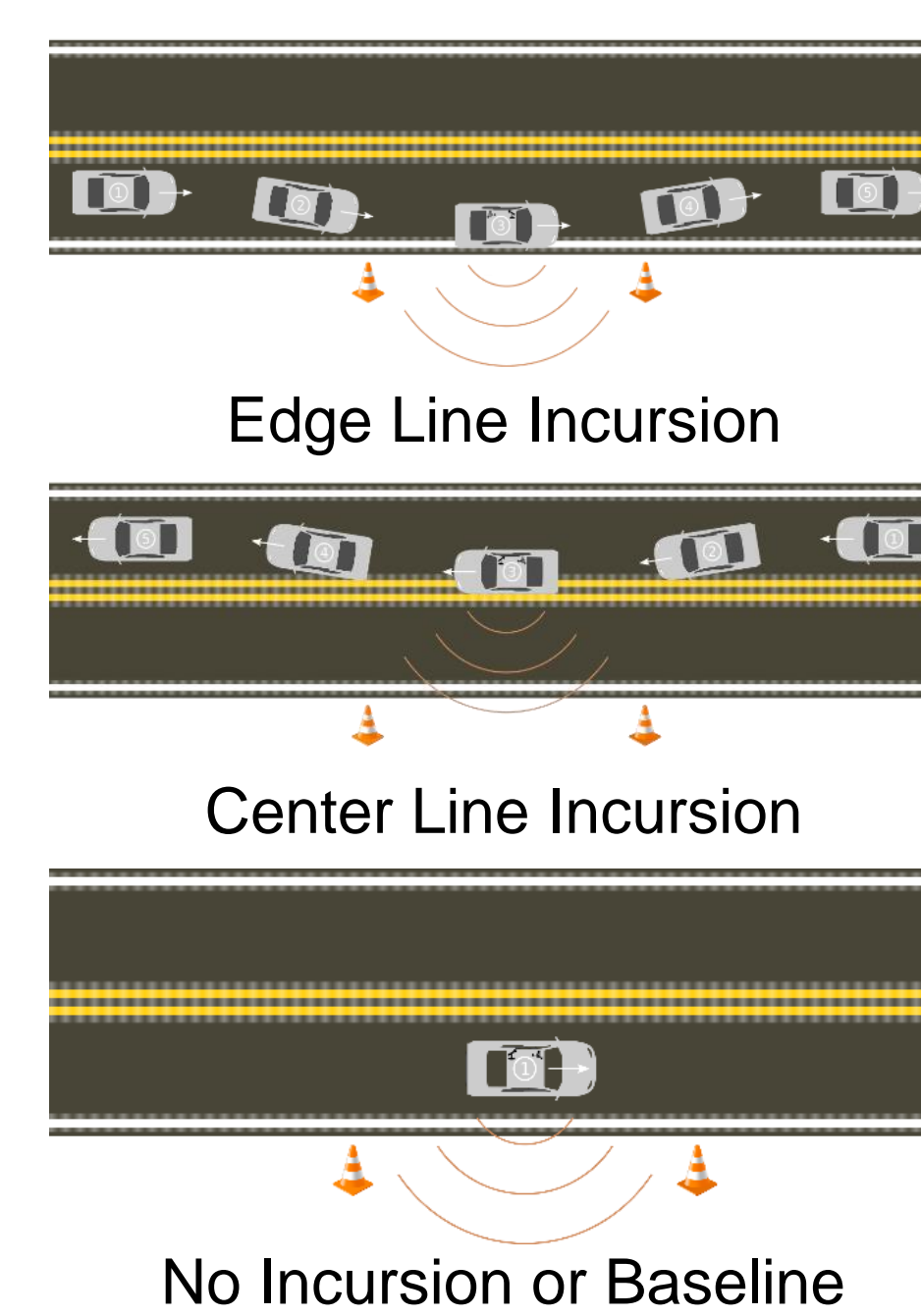
Study Corridor



Test Setup



Test Runs

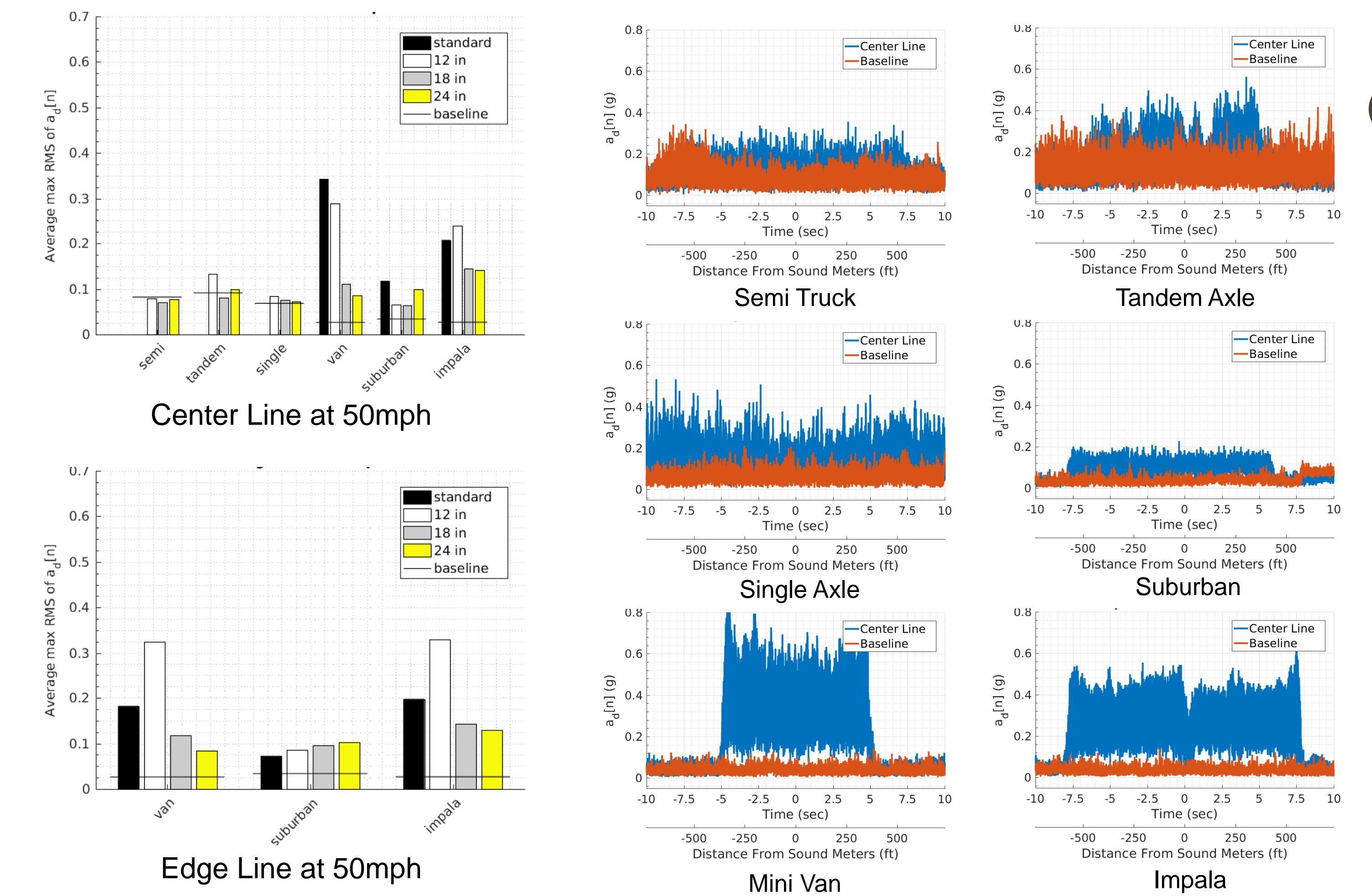


NCHRP Guidelines

	Outside	Inside
NCHRP* Recommendations	To limit exterior noise near residential land uses, sound should not increase by more than 12 dBA and preferably by less than 6 dBA	In-cabin (inside) sound level should increase by 10 dBA and preferably over 15 dBA.
6 12"	✔ 0 to 1 dBA above baseline	⚠ 4 to 12 dBA above baseline
18"	✔ 3 to 5 dBA above baseline	⚠ 1 to 5 dBA above baseline
24"	✔ 0 to 1 dBA above baseline	⚠ 0 to 4 dBA above baseline
Standard	⚠ 5 to 11 dBA above baseline	⚠ 5 to 8 dBA above baseline

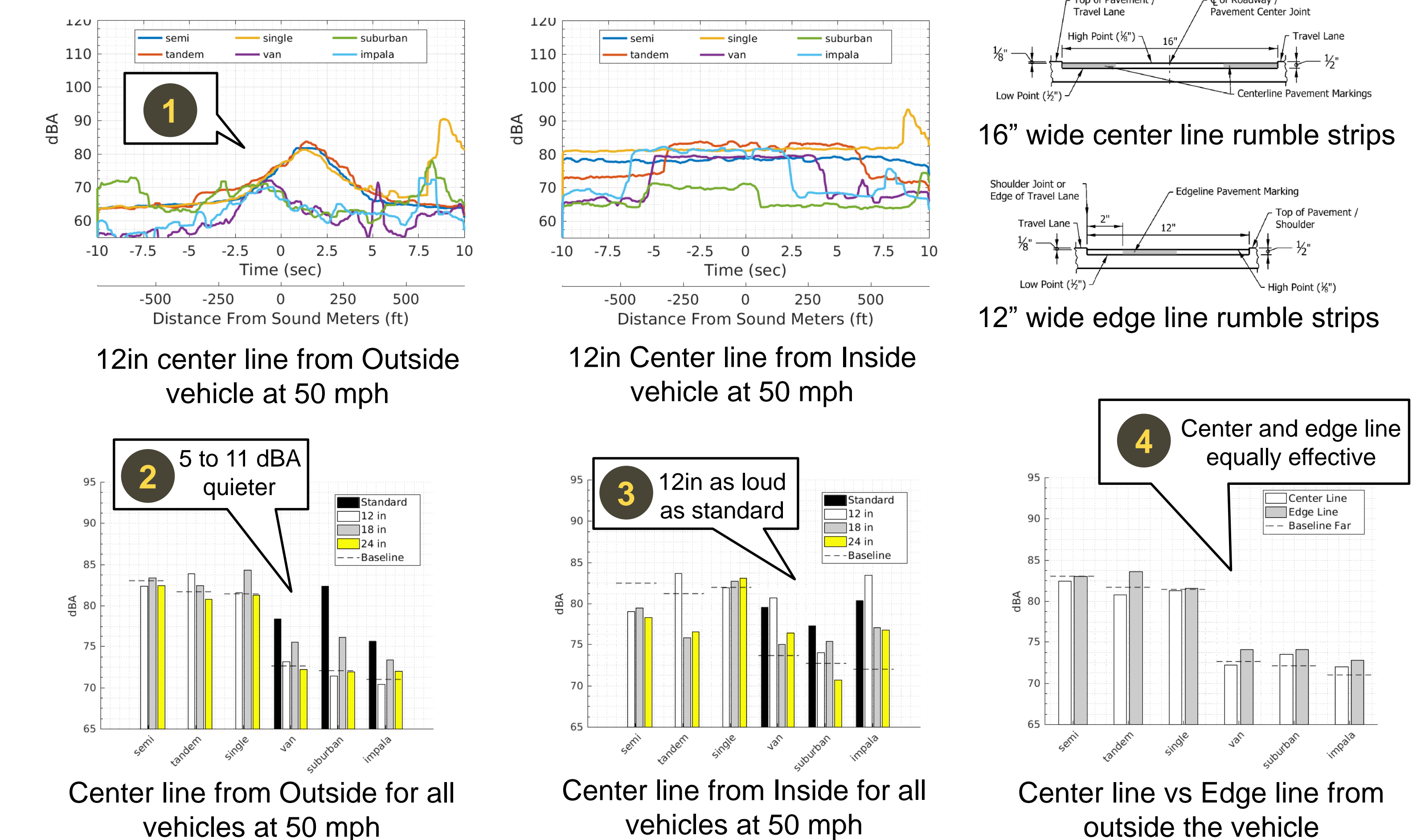
* NCHRP Report 641 on Guidance for Design and Application of Rumble Strips

Acceleration Results



Accelerations on 12in Sinusoidal Wavelength

Sound Level Results



Findings

- 1 Sound responses varied across the vehicles
- 2 From outside, 12in sinusoidal rumble strips were found to be 5 to 11dBA quieter than standard
- 3 From inside, 12in rumble strips were found to produce a sound level increase of 4 to 12 dBA compared to base line road noise
- 4 Sound levels from center and edge line rumble strips were found to be equally loud 50' off edge line
- 5 For heavy vehicles, engine noise and vibrations were found to dominate from inside the vehicle
- 6 Among the 3 sinusoidal wavelengths, 12" was the only one that routinely satisfied the NCHRP recommendations for in-cabin and exterior sound levels