Assessment of Alternative Sinusoidal Rumble Stripe Construction

Motivation

Studies have shown that rumble strips installed on a roadway significantly reduce the number of crashes 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 can travel at least several hundred feet at a volume that is considered a nuisance by nearby residents. To limit exterior noise, the National Cooperative Highway Research Program (NCHRP) Report 641 on the Guidance for Design and Application of Rumble Strips considers noise levels of 6 to 12 dBA above the roadway noise as acceptable. In recent years, a new rumble strip design in the form of a sine wave has been reported to produce low exterior noise, while still providing adequate warnings for drivers.

Study

Although studies on sinusoidal rumble strips are limited, the results have shown that they can significantly reduce exterior noise compared to traditional square designs. However, there are still questions regarding the impact of the waveform parameters (wavelength, depth, and amplitude on noise volume) and the alerting of drivers departing from their lane. This study evaluated three sinusoidal rumble strips of different wavelengths: 12”, 18”, and 24”. The sinusoidal rumble strips have fixed amplitude (3/16”) and depth (5/16”). The test bed was constructed on IN1, near Fort Wayne, Indiana, with each wavelength being approximately 4 miles long. Data was collected from six vehicles, ranging from a passenger car to a semi-truck at a speed of 50 mph. The rumble strips were quantitatively compared by measuring the noise inside and outside of the vehicle (50’ from edge line) as well as the vibration of the front seat frame. To exclusively capture the noise generated from the rumble strips, and for safety reasons, the tests were conducted using short-term flagging operations to temporarily restrict traffic. For comparison purposes, sound and vibration measurements were made on standard Indiana Department of Transportation (INDOT) rumble strips.

Results

Results showed that the sound responses varied across vehicles. For heavy vehicles, engine noise and vibrations were found to dominate from inside the vehicle. From the exterior, all three sinusoidal rumble strips were quieter than the traditional rumble strips, with a reduction in sound power by anywhere between 5 and 11 dBA. Interior cabin sound level was similar to standard rumble strips, with some selected cases increasing between 2 and 9 dBA.

Retro reflectivity tests were performed on the three sinusoidal patterns, a year after their installation, to evaluate the visibility during night and inclement weather conditions. The retro reflectivity tests on all three
sinusoidal patterns, on both the edge and center lines, were found to exceed the minimum threshold set by INDOT specifications.

**Recommendations**

The 12" sinusoidal rumble strip was the only pattern found to routinely satisfy the recommendations for incabin and exterior sound levels proposed by NCHRP Report 641. The width of the rumble strips did not play a major role in the noise, as the sound levels produced from the edge line and center line were equally loud in the interior. The retro reflectivity tests on all three sinusoidal patterns, on both the edge and center lines, were found to exceed the minimum threshold set by INDOT specifications.

Sinusoidal rumbles strips are a promising technology that is well suited for lane departure warning in residential areas. The results from this study suggest that the 12" wavelength has a desirable decrease in exterior noise while still maintaining reasonable or even, at times, superior (than the standard milled rumbles) lane departure warning to the driver.

**Recommended Citation for Report**


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