R-1336

# INTERIOR VEHICLE NOISE FROM SHOULDER RUMBLE STRIPS


## MATERIALS and TECHNOLOGY DIVISION

# INTERIOR VEHICLE NOISE FROM SHOULDER RUMBLE STRIPS

Fred Harwood
Ron Holcom

Research Laboratory Section
Materials & Technology Division
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Michigan Transportation Commission
Barton W. LaBelle, Chairman;
Richard T. White, Vice-Chairman;
Jack L. Gingrass, Robert M. Andrews,
Irving J. Rubin, John C. Kennedy
Patrick M. Nowak, Director
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## SUMMARY

Vehicle interior noise levels were analyzed while driving over ground-in-bituminous, rolled-in-bituminous, and cast-in-place concrete shoulder rumble strips. Three vehicles were used to make comparative tests on each type of rumble strip. The test vehicles used were a station wagon, a pickup with rear duals, and a van. Each vehicle was driven over the mainline roadway and then over the rumble strip. The interior noise level of the vehicle was measured while driven on the roadway and then compared to the interior noise level measured while driven over the rumble strip.

The change in noise level for all shoulder rumble strips was acceptable, and it was a significant increase (6 dBA or greater) that would be readily audible to the driver. The rolled-in-bituminous and ground-in-bituminous were twice as noisy (10 dBA or greater increase) as the main roadway level.

As would be expected, there were differences in interior noise between the vehicles during the tests. The station wagon was quieter than the other two vehicles on the mainline roadway. The heavier truck with six tires was quieter than the van. The greatest increase in noise level was measured with the van driving on the ground-in-bituminous rumble strip, and it also produced the maximum rumble strip noise.


## INTRODUCTION

Rumble strips on roadway shoulders are installed to alert the driver that the vehicle has left the main roadway and is about to leave the paved shoulder. This report analyzes the interior noise levels in three vehicles travelling over ground-in-bituminous, rolled-in-bituminous and cast-in-place concrete shoulder rumble strips. This report only considers the dBA level and does not study the psychological differences in the type of noise, such as pulsing noise, or the frequency and length of time on rumble strip.

### Tests

The three shoulder surfaces selected were: 1) rumble strips ground into the bituminous after the surface was set and the roadway opened to traffic; 2) rumble strips rolled into the bituminous before the surface had set or cooled; and 3) rumble strips formed in the concrete before the surface had set. Surface 1 was a new rumble strip being tested for the Department. Surfaces 2 and 3 were rumble strips installed in accordance with Standard Design Plan V-112K. The three vehicles selected were: a Pontiac Safari station wagon; a Ford F-350 pickup with duals in the rear; and a Dodge 350 Ram van. The tests were made at 50 and 60 mph. Each combination of rumble strip, vehicle, and speed was tested three times.

Different methods were used to run over the shoulder rumble strips during each test. Since the ground and rolled strips in bituminous were continuous, a weave method was used to cross the rumble strip six times per test run. The maximum noise level reported was the highest of the six crossings. The ground rumble strips had a mainline

roadway surface of bituminous and the rolled rumble strips had a mainline surface of concrete.

The cast-in-place concrete rumble strips were not continuous. The rumble strips were 5 3/4 ft long and 82 ft apart. The vehicle was weaved onto the strips and then off. The right wheels of the vehicle were driven straight down the shoulder over six rumble strip clusters. The maximum noise recorded was the highest of the six noise levels made while passing over the strips. $L_{eq}$ noise levels were also taken over a 10 sec time period on the mainline pavement; the vehicle was not weaved onto the shoulder during these tests.

Analysis

Table 1 shows the average of three noise level values taken during the tests. The noise level difference between mainline pavement $L_{eq}$ and the maximum rumble strip noise is the stimulus that alerts the vehicle driver. Table 1 also shows these differences. Figure 1 shows the 50 mph values and Figure 2 shows 60 mph values determined from these tests.

A three decibel difference is not perceptible to the driver, but a 6 dBA difference or more is a significant difference and is readily audible to the driver. A ten decibel increase is an apparent doubling of noise to the driver. The cast-in-place concrete rumble strips provide a significant difference in noise level for the driver in all three vehicles. Both types of bituminous rumble strips provide at least a doubling of the noise level in all vehicles. The noise difference ranged from 9.6 dBA to 20.7 dBA.

Different vehicles produced different interior noise levels. The ground-in-bituminous rumble strip had a greater effect on interior noise in two of the three vehicles. The noise level in the station wagon while traveling on the mainline freeway averaged 66.5 dBA compared to the other two vehicles which averaged 71.3 dBA. This was an expected result. However, the van was not expected to be noisier than the pickup. The van had four 16-in. tires while the pickup had six 16-in. tires. Also, the van was lighter than the pickup and had an all-vinyl interior while the pickup had a fabric ceiling. Tires on all three vehicles were "all season" radials.

Recommendations

1. The three types of rumble strips tested should be allowable alternatives when specifying shoulder rumble strips.

2. When new specifications or construction methods are proposed for shoulder rumble strips an approximate 1,000 foot test section should be constructed. The Research Laboratory will evaluate the strip for specification compliance, noise level differences, and durability.

TABLE 1
INTERIOR NOISE OF RUMBLE STRIPS ON SHOULDER
COMPARISON OF MAINLINE $L_{eq}$ AND MAXIMUM SHOULDER NOISE IN dBA

| Vehicle | Tires | Speed, MPH | Site 1 | | | Site 2 | | | Site 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Concrete Mainline, Leq | Rumble Strip Concrete Cast-in-Place, Max. | Difference | Concrete Mainline, Leq | Rumble Strip Rolled-in-Bituminous Max. | Difference | Bituminous Mainline, Leq | Rumble Strip Ground-in-Bituminous | Difference |
| Dodge van #23203 | Michelin LT 225/75 R-16 M&S Radial | 50 | 71.5 | 80.6 | 9.1 | 71.3 | 84.4 | 13.1 | 69.7 | 90.4 | 20.7 |
| | | 60 | 74.9 | 82.0 | 7.1 | 73.4 | 83.0 | 9.6 | 71.9 | 91.2 | 19.3 |
| Pontiac station wagon #14011 | UniRoyal Tiger Paw P225/75R15 M&S Radial | 50 | 67.0 | 72.5 | 5.5 | 65.9 | 77.8 | 11.9 | 63.7 | 80.6 | 16.9 |
| | | 60 | 68.8 | 78.6 | 9.8 | 67.9 | 80.8 | 12.9 | 66.0 | 84.4 | 18.4 |
| Ford 350 pickup #27404 | Firestone Steeltex LT215/85R16 M&S Radial | 50 | 70.0 | 81.3 | 11.3 | 70.6 | 82.3 | 11.7 | 67.5 | 83.2 | 15.7 |
| | | 60 | 72.0 | 80.3 | 8.3 | 72.2 | 85.3 | 13.1 | 70.0 | 84.7 | 14.7 |

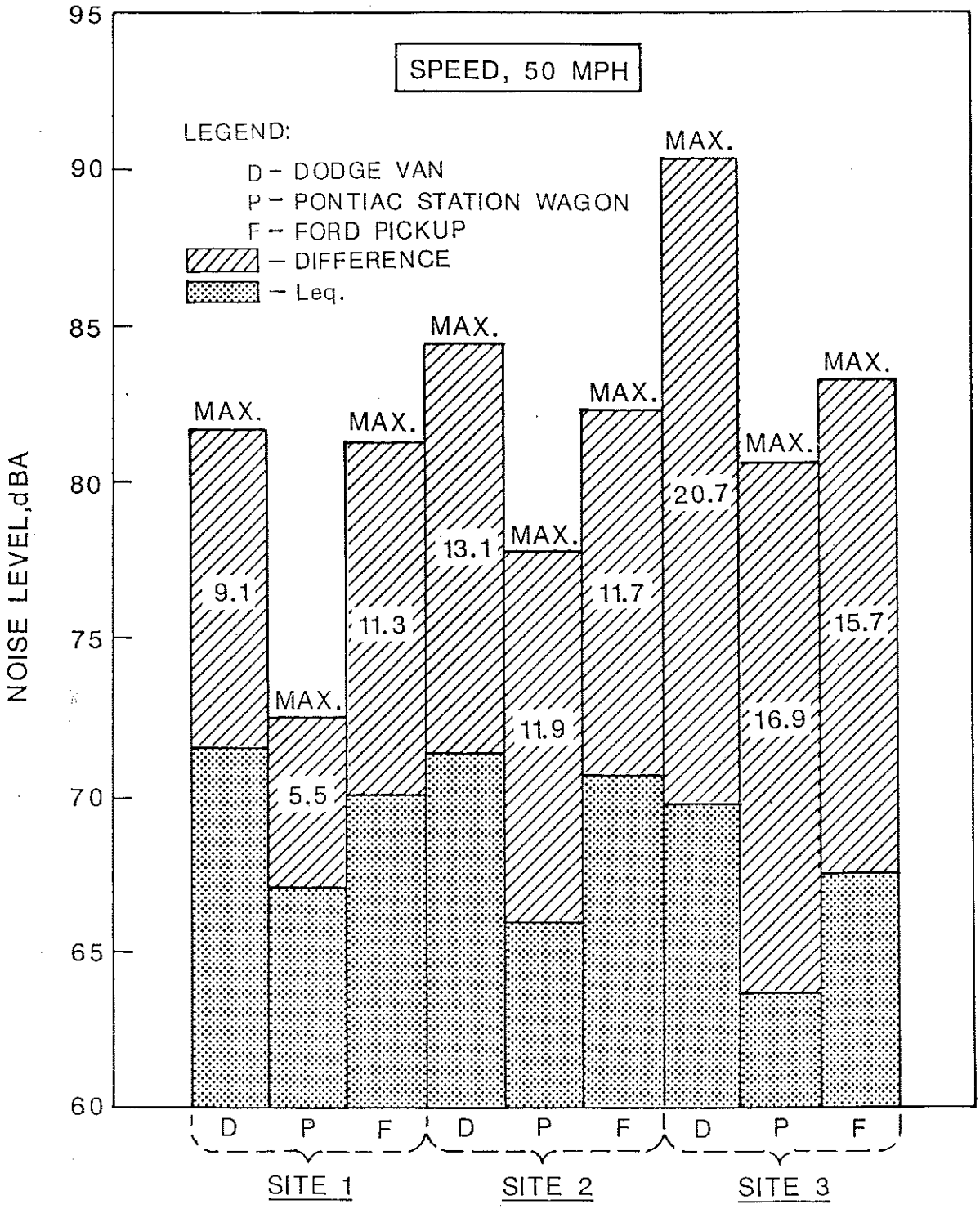


Figure 1. Interior noise of rumble strips on roadway shoulders.
Speed, 50 MPH

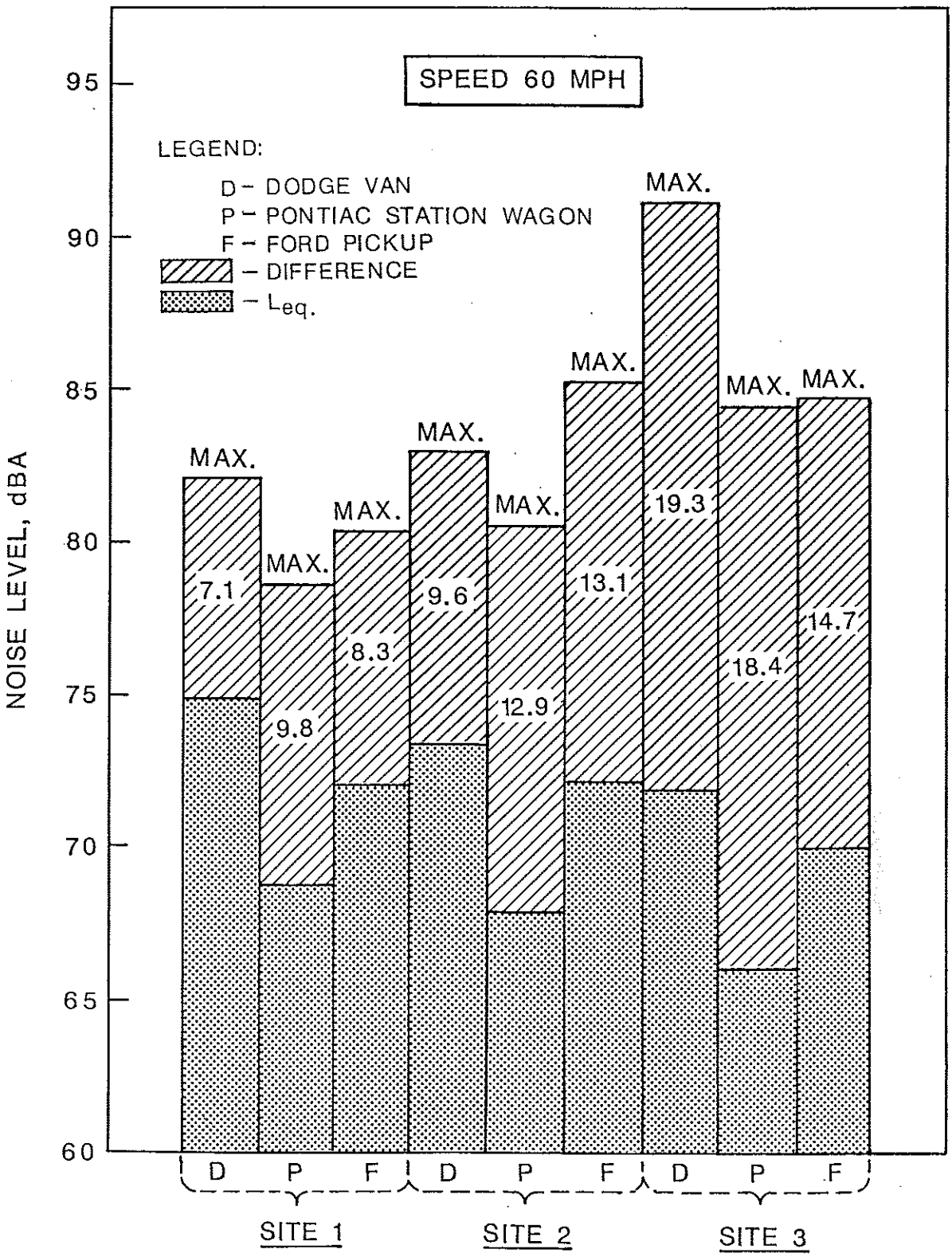


Figure 2. Interior noise of rumble strips on roadway shoulders. Speed, 60 MPH