

NWPMA 2010 Fall Conference
"Shrinking Budgets & Creative Management"
October 29, 2010

Rumble Strips and Rumble Stripes

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U.S. Department
of Transportation
**Federal Highway
Administration**

NCHRP

REPORT 641

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

**Guidance for the Design
and Application of Shoulder
and Centerline Rumble Strips**

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES



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Objective

- Develop further guidance for the design and application of shoulder and centerline rumble strips as an effective motor vehicle crash reduction measure, while minimizing adverse effects for motorcyclists, bicyclists, and nearby residents



Safety Effectiveness of Shoulder Rumble Strips

- Rural freeways

Shoulder rumble strips (combined)

- SVROR crashes AMF = 0.89 (SE = 0.1)
- SVROR FI crashes AMF = 0.84 (SE = 0.1)

- Rural two-lane roads

Shoulder rumble strips

- SVROR crashes AMF = 0.85 (SE = 0.1)
- SVROR FI crashes AMF = 0.71 (SE = 0.1)



Safety Effectiveness of Shoulder Rumble Strips (cont)

- On rural freeways, rumble strips placed closer to edgeline are more effective at reducing SVROR FI than rumble strips placed further from edgeline
- No difference on rural two-lane roads



Safety Effectiveness of Centerline Rumble Strips

- Urban two-lane roads (NCHRP 641)
 - 40% reduction in TOT target crashes (SE = 17)
 - 64% reduction in FI target crashes (SE = 27)
- Rural two-lane roads (NCHRP 641 and Persaud et al. [2003])
 - 9% reduction in TOT crashes (SE = 2)
 - 12% reduction in FI crashes (SE = 3)
 - 30% reduction in TOT target crashes (SE = 5)
 - 44% reduction in FI target crashes (SE = 6)



AMF for Installing Centerline Rumble Strips (AMF)

Exhibit 13-55: Potential Crash Effects of Installing Centerline Rumble Strips

Treatment	Setting (Road type)	Traffic Volume AADT	Accident type (Severity)	AMF	Std. Error
Install centerline rumble strips	Rural (Two-lane)	5,000 to 22,000	All types (All severities)	0.86	0.05
			All types (Injury)	0.85	0.08
			Frontal and opposing-direction sideswipe (All severities)	0.79	0.1
			Frontal and opposing-direction sideswipe (Injury)	0.75	0.2
Base Condition: Absence of centerline rumble strips.					



U.S. Dept. of Transportation NOTE: Based on centerline rumble strip installation in seven states: California, Colorado, Delaware, Maryland, Minnesota, Oregon, and Washington

Safety Effectiveness of Centerline Rumble Strips (cont)

- Centerline rumble strips on horizontal curves and tangents provide similar safety benefits



if
on
way
on

Centerline and Shoulder RS



Video



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Stimuli Levels Necessary for Effective Rumble Strips

- No conclusive evidence concerning minimum stimuli levels needed to be generated by rumble strips to be effective
- Sources indicate that to reach the alerting level, the noise level should increase approximately 3, 4, 6, or 10 dBA above the ambient
- 15 dBA increase necessary for non-speech warning sounds
- One source reports that sound level changes above 15 dBA could produce a startle reaction

Summary of Noise Prediction Models

- Unit increases in length, width, and depth dimensions increase noise levels in passenger compartment
- Unit increase in space dimension decreases noise level in passenger compartment
- Centerline rumble strips generate more noise than shoulder rumble strips



Rumble Strip Application and Design Criteria (Shoulder)

- Roadway types where it is appropriate to install shoulder rumble strips
 - Rural and urban freeways, ramps, multilane divided and undivided roads, and two-lane roads
 - Criteria to be considered in determining whether implementation is appropriate:
 - Shoulder width
 - Lateral clearance
 - Traffic volume
 - Speed limit
 - Bicycles
 - Pavement type
 - Pavement depth
 - Area type
 - Crash experience
 - Expected safety benefits



Rumble Strip Application and Design Criteria (Shoulder)

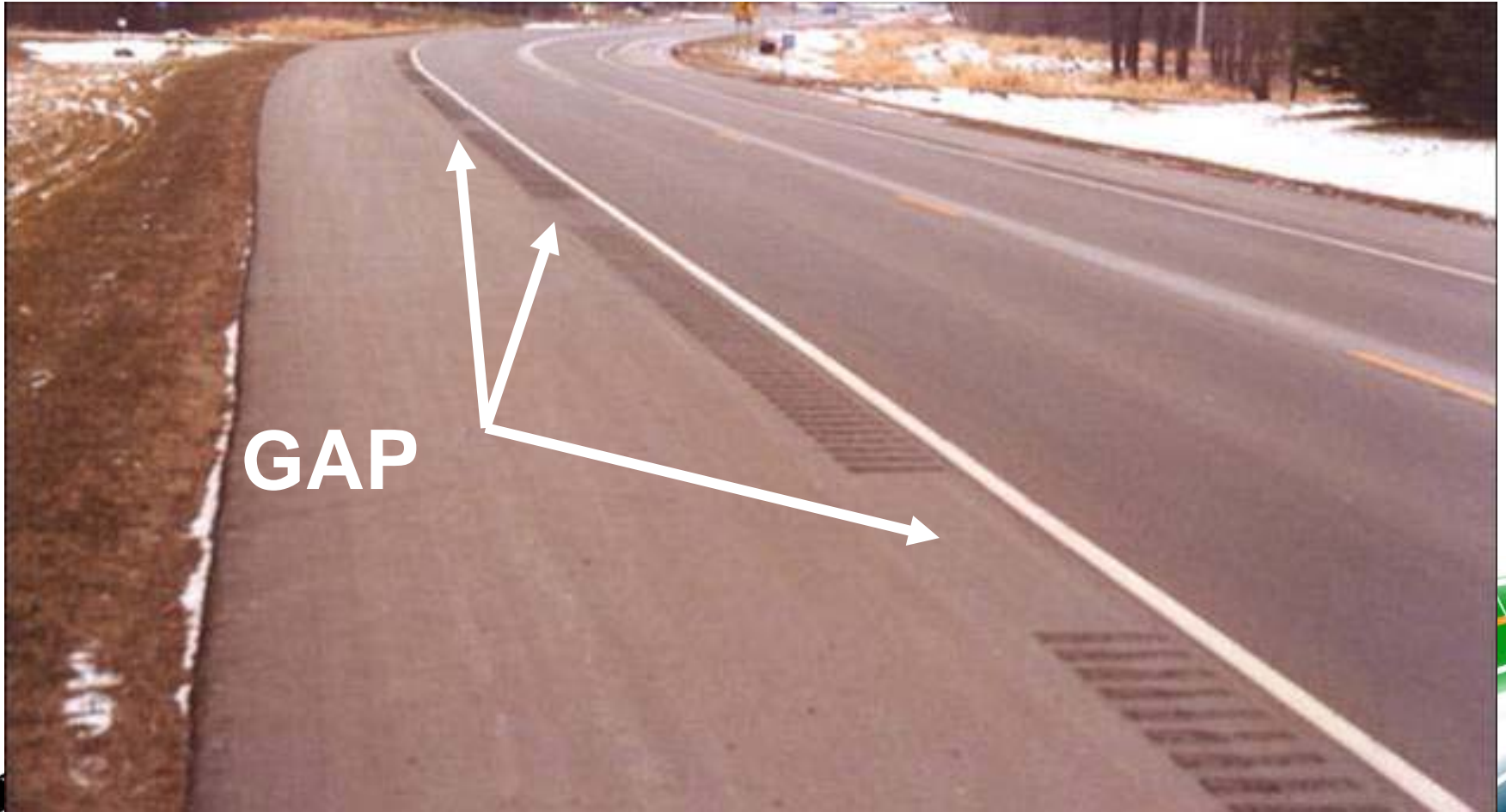
- Dimensions of shoulder rumble strips
 - Recommend designing for 10 to 15 dBA increase on roadways where bicyclists are not expected
 - Recommend designing for 6 to 12 dBA increase on roadways where bicyclists are expected
 - Noise prediction models available for design purposes



Rumble Strip Application and Design Criteria (Shoulder)

- Dimensions of shoulder rumble strips (cont)
 - Common dimensions of milled rumble strips
 - Length: 16 in
 - Depth: 0.5 to 0.625 in
 - Width: 7 in
 - Spacing: 12 in
 - Common dimensions of bicycle tolerable shoulder rumble strips
 - Width: 5 in
 - Depth: 0.375 in
 - Spacing: 11 to 12 in
 - Rumble strips designed with narrow lengths (e.g., 6 in) can generate desired sound levels





Rumble Strip Application and Design Criteria (Shoulder)

- Placement of shoulder rumble strips relative to edgeline
 - On rural freeways, place as close to the edgeline as possible, taking into consideration other factors
 - On other roadway types, no basis for recommending change of current policy
 - Concerns over the visibility/retroreflectivity of pavement markings should not prohibit the use of edgeline rumble strips



Rumble Strip Application and Design Criteria (Centerline)

- Roadway types where it is appropriate to install centerline rumble strips
 - Rural and urban multilane undivided roads and two-lane roads
 - Criteria to be considered in determining whether implementation is appropriate:
 - Lane width
 - Traffic volume
 - Pavement depth
 - Bicycles
 - Area type
 - Speed limit
 - Crash experience
 - Expected safety benefits



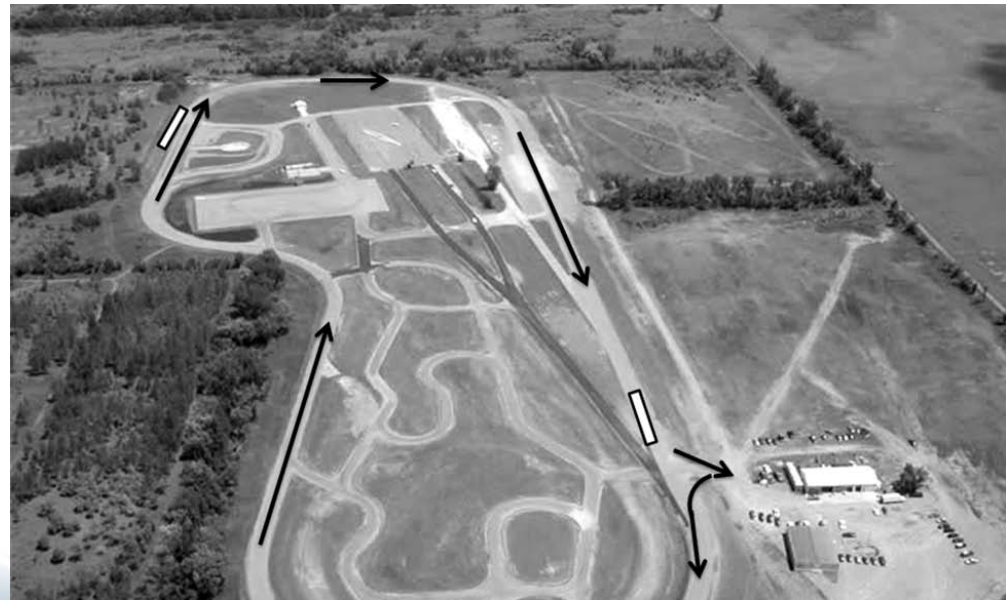
Rumble Strip Application and Design Criteria (Centerline)

- Roadway types where it is appropriate to install centerline rumble strips (cont)
 - No adverse effects for motorcyclists when developing centerline rumble strip policy
 - MUTCD requires signing



Centerline Rumble Strips & Motorcyclists

- Minnesota DOT Study - “Effects of Centerline Rumble Strips on Motorcycles”
 - Reviewed crash history of locations with CLRS
 - Reviewed 44 hours of direct and video recordings of locations with CLRS
 - Observed riders on a closed course with CLRS



<http://www.lrrb.org/pdf/200807TS.pdf>



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Centerline Rumble Strips & Motorcyclists

Minnesota DOT Study Findings

- Zero of 9845 motorcycle crash reports mentioned rumble strips as a factor
- 44 hours of observation showed:
 - Small number of rumble strip crossings
 - No instances of directional changes or unusual riding behavior during crossing.
 - Rumble strips did not seem to inhibit any passing opportunities.
- Closed-course examination showed no steering, braking or throttle adjustments during strip crossing.
 - Post-ride interviews confirmed these observations
 - No rider expressed difficulty or concern with crossing rumble strips.



**Conclusion - no indication that centerline
rumble strips pose a hazard to cyclists**

Rumble Strip Application and Design Criteria (Centerline)

- Dimensions of centerline rumble strips
 - Recommend designing for 10 to 15 dBA increase
 - Noise prediction models available for design purposes
 - Common dimensions of centerline rumble strips
 - Length: 12 or 16 in
 - Width: 7 in
 - Depth: 0.5 in
 - Spacing: 12 in



Rumble Strip Application and Design Criteria (Centerline)

- Placement of centerline rumble strips relative to the centerline pavement markings
 - Extend into the travel lane (most common)
 - Within the pavement markings
 - On either side of the centerline pavement markings (least common)
- Concerns over the visibility/retroreflectivity of pavement markings should not prohibit the use of centerline rumble strips



Placement of Centerline Rumble Strips (cont)

Centerline rumble strips extend into travel lane (most common)



Centerline rumble strips within pavement markings



Centerline rumble strips on either side of pavement markings (least common)



Rumble Strip Application and Design Criteria (Centerline)

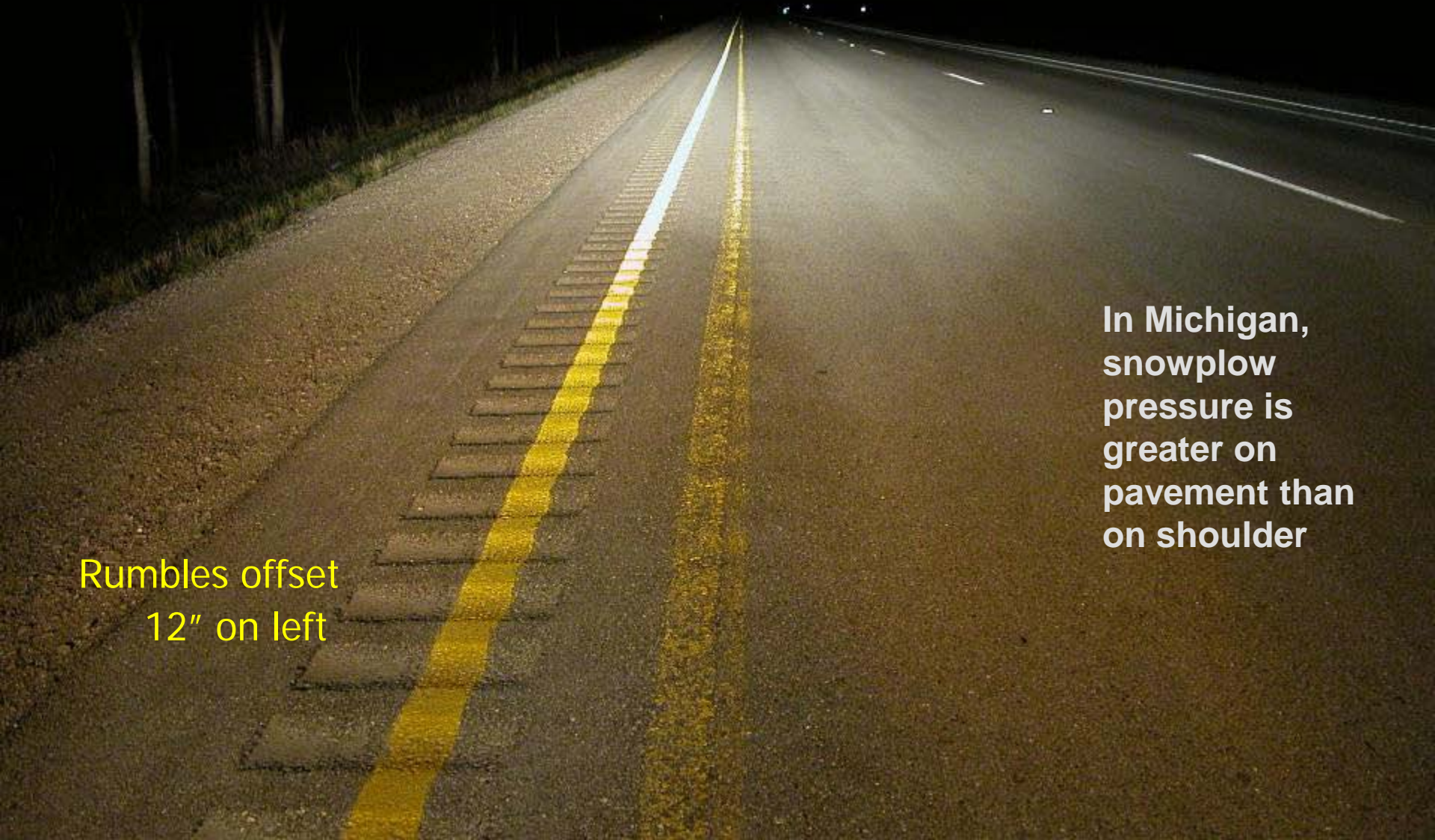
- Features or areas that might necessitate an interruption in the centerline rumble strip pattern, include:
 - Intersections and driveways
 - Structures (i.e. bridges)
 - Passing zones
 - No conclusive evidence to recommend that centerline rumble strips should be discontinued within passing zones



After one winter - dry night

Rumbles offset
12" on left

In Michigan,
snowplow
pressure is
greater on
pavement than
on shoulder



Single 6" edge line

- Research: traffic stream shifts approx 6" toward edge line
- Noise problems near some curves

Double 4" edge line

- Concern - MUTCD/Meaning of double line



Mississippi Rte 589



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