Rumble Strip Policy Background

The following discussion explains some of the decisions that went into the DOT&PF rumble strip policy.

Rumble Time – a Primary Consideration.

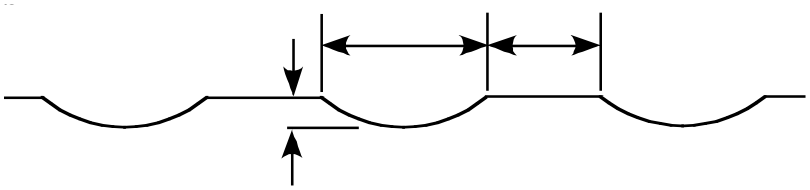
One important, but often overlooked, issue is the length of time errant drivers typically spend on rumble strips. Motorists who test-drive rumble strips, usually by driving on them for several seconds, often don't understand why the rumbles need to be so loud and aggressive. What they're missing is how brief rumble time is for drivers who are at risk of leaving the road – around 6/10 of a second of outside-tire rumble for drivers leaving at a 3 degree angle (less than 2/10 of a second if you only count the time the tire is in full-width contact with the rumble). Departures at greater angles result in even less rumble time. It takes a lot of noise and vibration to wake drivers in such a short time. For this reason, we need to be conservative with any modifications that reduce noise, vibration, or rumble time.

Milling Pattern

We have chosen the common 7" wide, _" deep cut pattern over the newer 5" cut patterns recommended by Pennsylvania DOT in their "Bicycle-Tolerable Shoulder Rumble Strips", 2000, for the following reasons:

1. 5" cut rumble strips are substantially quieter than 7" cut rumble strips.
2. 5" cut rumble strips are quieter yet for large-tired vehicles such as trucks and buses.
3. 5" cuts are slower to install and are consequently more expensive. According to Surface Preparation Technologies, the company that did the Central Region rumble strips last year, 5" / 3/8" cuts take more than four times as long to install as the 7" / _" cut installed in Central Region. This is because they have to slow much more for each 5" cut than they do for the more gradual 7" cut.
4. Surface imperfections result in a large depth variance in the 5" / 3/8" cuts (machine tolerance is a greater proportion of total cut depth).
5. There is little, or no, actual accident data on the effectiveness of 5" cuts. Pennsylvania has installed few of these on their roads as of May 2001.
6. Although a 5" / _" cut was list as one of the options in the PennDOT study (and was selected as the DOT&PF standard in the first draft of this policy), it is not possible to cut rumbles to those dimensions given the dimensions of the milling machine used (The 16" mill can't cut that deep with a 5" width).

Until additional testing and post-project crash analysis identifies patterns that are bicycle-friendly, effective, and economical, the department should stay with the pattern used in Central Region last year. This is the Sonic Nap Alert Pattern (SNAP) developed by the Pennsylvania Turnpike Authority in the mid 1990s. It is the pattern that most states with milled rumble strips use, according to the FHWA Rumble Strip Web Site, and the pattern that the outstanding safety record of milled rumble strips resulted from.



Sonic Nap Alert Pattern

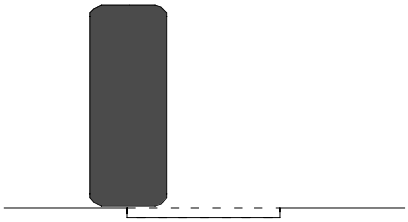
Rumble Strip Lateral Width.

The most common width of milled rumble strips in the U.S. is 16". This width has contributed to the outstanding crash-reduction record of rumble strips. We have been asked to change the standard width to 12" in Alaska.

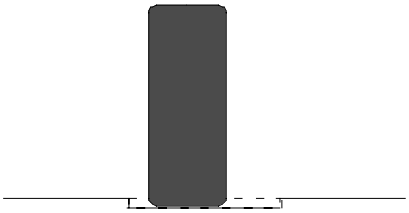
Going to a 12" width would allow us to provide more clear shoulder space for bicycles and/or greater offset from the shoulder stripe. On the other hand, it would reduce rumble time and, as a consequence, rumble strip effectiveness.

1. Effectiveness.

Sixteen inch rumbles sound significantly more substantial than twelve inch rumbles when crossed at an angle - more than you would expect from a 33% increase in width. To a large degree, this is due to the increased time tires are in full-width contact with the rumble.



Partial Tire-Width Rumble Contact



Full Tire-Width Rumble Contact

Full tire-width rumble contact allows the tire to fully drop into the rumbles. It is the loudest interval of a rumble strip crossing and is most effective at getting drivers' attention. Its duration *doubles* when rumble width increases from 12" to 16" (assuming an 8" tire contact patch).

Wider rumble strips also improve safety on intermittent rumble strips. Additional width reduces the probability of a car's outer tires driving through a gap without contacting the rumble.

2. Clear shoulder space.

The 12" width would give an additional 4" that could be used to widen the clear shoulder space. However, according to Central Region personnel, this rarely would have made the difference between having adequate and inadequate shoulder width on their rumble strip project. On roads with 8' or 10' shoulders, it never would have made that difference.

3. Offset

The additional 4" could also be used to increase the offset between the shoulder stripe and the rumble from 4" to 8". This would reduce inadvertent contact with rumble strips but would also limit the debris-free area available for bicyclists on the outside of the rumble. There is little agreement on how much of a benefit, or disadvantage, an increased offset would be.

In summary, going to 12" from 16" would trade an important safety advantage, half of the full-contact rumble time, for a less important consideration – 4" more space for shoulder or offset.

We should retain the 16" width that has proven effective throughout the nation.

Offset from Shoulder Stripe.

The Central Region shoulder rumble strips were installed at 4" from the edge of the shoulder stripe. Current recommendations by DOT&PF personnel range from 2" to 10".

Considerations:
1) Larger offsets would reduce the frequency of accidental rumble strip contact.
2) Larger offsets postpone the time when a dozing driver contacts the rumble, thus limiting the time and area available for recovery.
3) Larger offsets limit the clear width available for bicyclists.
4) Larger offsets move bicyclists further into the debris on the shoulder. Wind blast from cars keeps the inner part of the shoulder clear. This may result in bicyclists riding on the road side of the rumble strip.
5) Smaller offsets may improve striping longevity (due to drivers shying away from the rumbles)
6) Offsets larger than 6" would preclude the use of 16" rumbles on 6' shoulders. A 6" offset with a 16" rumble would allow no margin of error for varying pavement widths or stripe alignment.

To maintain room for larger rumbles and some margin of error for clear width for bicycles, the inner edge of rumble strips should be offset 2" from the outer edge of the shoulder stripe on 6' shoulders. On wider shoulders, which have more than the required clear width for bicyclists, an offset of 6" would reduce inadvertent rumble contact to some extent.

Gaps.

The ideal rumble strip gap pattern would allow all bicyclists at all speeds to cross without rumble contact but ensure that all departing automobiles at all departure angles would contact the rumbles for long enough to wake them. In practice, this is unattainable. The long, frequent gaps desired by bicyclists would result in some automobiles either missing the rumbles entirely or having too little rumble time to wake them.

Every gap pattern is a compromise between bicycle-friendliness and vehicle safety. Because we have to act with limited information (there is little data on the effectiveness of intermittent rumble strips), we should err on the side of vehicle safety.

The following facts are pertinent:

1. Florida is reportedly using a 7' rumble, 5' (4'5" edge to edge) gap pattern.
2. A recent Arizona study recommends either a 28' or a 48' rumble with a 12' gap.
3. The 12' gap recommended by the Arizona study was based on 100% of riders of varying abilities on different types of bikes being able to cross the gap without slowing from 25 MPH without touching a rumble on either side.
4. As shown on the roughly-to-scale drawings on the following page, gaps can significantly reduce the effectiveness of rumble strips, either by allowing drivers to miss them, or by reducing the duration and volume of rumble noise and vibration.
5. It is not difficult to drive off the road at an angle that would allow a car's outside tires to drive through a 12' gap without significant rumble contact. It is difficult to attain the angle necessary to clear a 5'5" gap. However, it is not difficult to attain the angle necessary to cross either with no full-tire-width rumble contact.
6. In addition to gap length, gap frequency plays an important part in the likelihood that rumble time will be reduced. Less frequent gaps reduce the probability that errant drivers will encounter them.

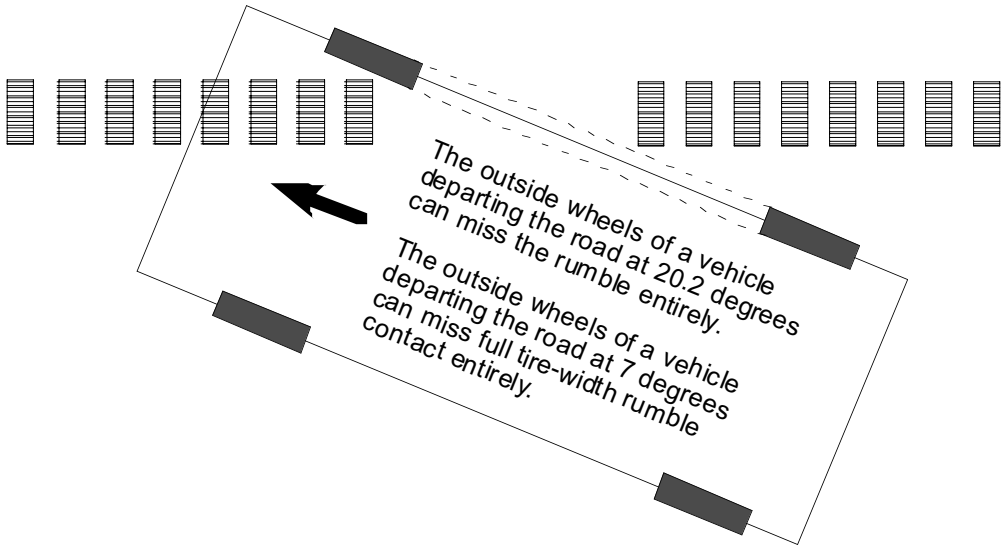
This information leads to no exact answer. However, because short gaps have the least negative impact on safety and still provide a significant benefit to bicyclists, they are the best choice.

A one foot increase over the 4'5" gap used in Florida (and installed on Hiland Road) would make bicycle crossing a little easier. It would result in 14% gaps in the rumble strip, which reduces the probability of encountering them, and would require motorists to depart at an unusually high angle to entirely miss the rumbles. It requires high-speed bicyclists to either slow or clip a few rumbles as they cross the gap.

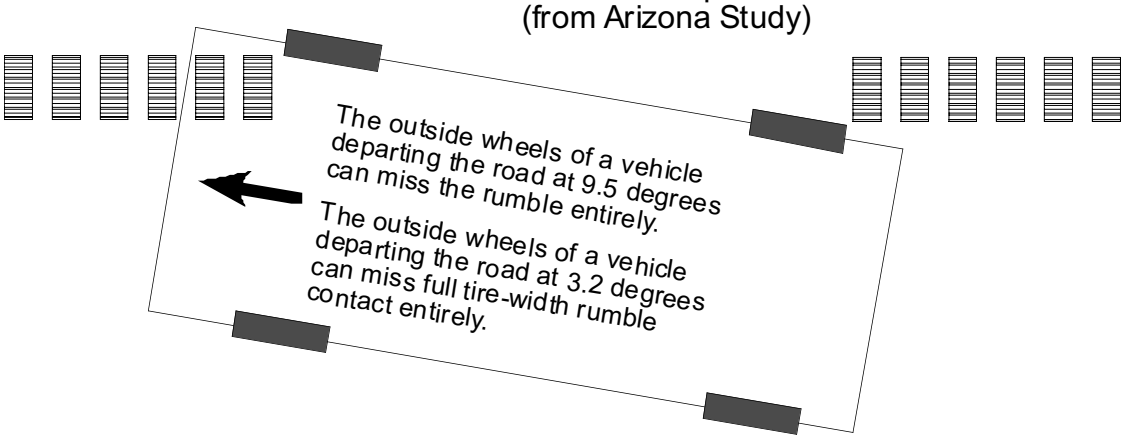
The 40' cycle recommended by the Arizona study provides crossing opportunities every 1.8 seconds for bicyclists traveling at their average speed of 15 MPH.

Consequently, go with 6' center to center (5'5" edge to edge) gaps every 40'.

6‘ Nominal Gap
(5’5“ actual groove to groove)
(Alaska Policy)



12‘ Gap
(from Arizona Study)



5‘ Nominal Gap
(4’5“ actual groove to groove)
(Florida and Kansas Policy)