Delaware Department of Transportation
Division of Transportation Solutions
Design Guidance Memorandum

Memorandum Number 1-18 Revised

1. Road Design Manual 2. Bridge Design Manual 3. Utilities Design Manual
4. Real Estate Manual 5. Standard Specifications 6. Standard Construction Details

Title: Continuous Center Line and Longitudinal Edgeline Rumble Strips Effective date: 10/2/14

Sections to Implement:

X Project Development	X Planning	___ DTC
X Bridge	X Quality	X Traffic
X Team Support	X Maintenance & Operations	___ Other _____
X Utilities		

I. Purpose

To define when and where center line or continuous edgeline longitudinal rumble strips should be applied within the state highway system. (See Figures 1 through 5.)

II. Design Guidance

The purpose of center line or continuous edgeline longitudinal rumble strips is to enhance safety by mitigating the potential of crossover or road departure crashes. Rumble strips are intended to alert drivers by creating an audible (noise) and tactile (rumble or vibratory) warning sensation to indicate to the driver that the vehicle is leaving the traveled way (traffic lane) and that a steering correction may be required. Before and after crash studies have indicated that both crossover and roadway departure crashes may be reduced significantly by the use of rumble strips.

The intent of the rumble strip is to gain the attention of a driver. Naturally, the byproduct of this measure is noise. In isolated areas this is usually not a problem. However, when installed in a suburban or urban area, the noise from rumble strips may impact nearby residents. The noise impacts should not be dismissed; it is highly recommended to consider the noise implications of rumble strips if they are going to be located in populated areas. If there is any concern that noise could be an issue, Engineering Support should be consulted.

Continuous longitudinal milled rumble strips should be considered and installed per the following guidelines and details.

A. Edgeline Rumble Strips

1. Interstates, Freeways and Expressways (Limited Access Facilities)
    a. Continuous edgeline rumble strips should be installed on new, reconstructed and resurfaced shoulders (inside and outside shoulders) of all Interstates, freeways and expressways, regardless of crash history.
    b. Continuous edgeline rumble strips should be installed on both the inside and outside shoulders of new, reconstructed and resurfaced interchange ramps regardless of crash history.
    c. The design of the continuous edgeline rumble strips should be in accordance with Figures 1A, 1B and 1C.

d. Rumble strips shall not be installed on bridge decks without approval from the DelDOT Bridge section.

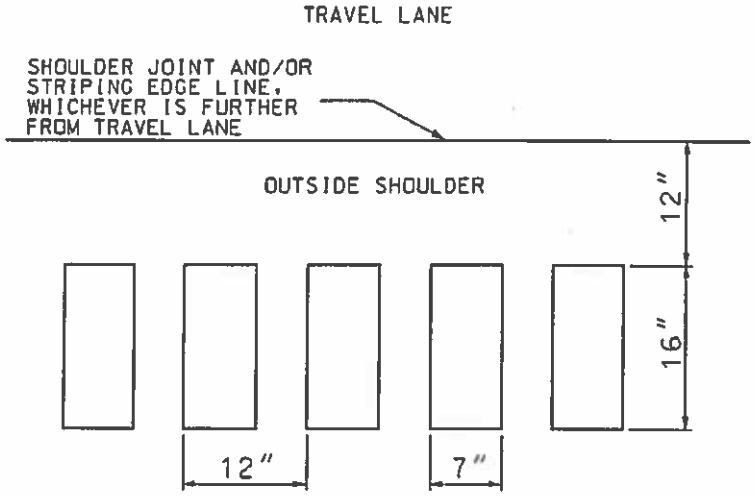


FIGURE 1A
CONTINUOUS EDGELINE RUMBLE STRIP DETAILS
NOT TO SCALE

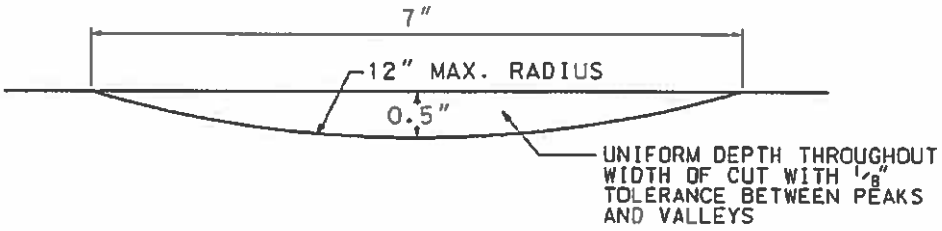


FIGURE 1B
RUMBLE STRIP SECTION – INTERSTATES, FREEWAYS AND EXPRESSWAYS
NOT TO SCALE

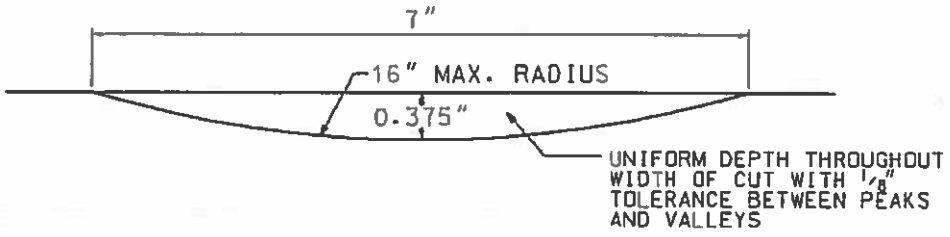


FIGURE 1C
RUMBLE STRIP SECTION – BRIDGE DECK RUMBLE STRIPS
NOT TO SCALE

2. Multilane Conventional Roadways

   a. Bicycle-Friendly Edgeline Rumble Strips should be installed on new, reconstructed or resurfaced outside shoulders of all multilane conventional roadways. Continuous edgeline rumble strips should be installed on new, reconstructed or resurfaced inside shoulders of all multilane conventional roadways. DelDOT's Bicycle Coordinator should be notified prior to new installations of edgeline rumble strips on any multilane conventional roadway.

   b. Bicycle-Friendly Edgeline Rumble Strips should be installed as shown in Figures 2A, 2B and 2C.

   c. Rumble strips shall not be installed on bridge decks without approval from the DelDOT Bridge section.

   d. Rumble strips are to be broken for all intersections and driveway entrances where the edgeline pavement markings tie into the driveway entrance or where the edgeline pavement markings are broken. The installation of rumble strips should be stopped 25 feet prior to the Point of Curvature (PC) and restarted 25 feet after the Point of Tangency (PT).

   e. Rumble strips should not be installed on acceleration, deceleration or bypass lanes, or two-way left turn lanes. Installation should stop 150 feet prior to the diverge point of a deceleration lane and should not commence until 150 feet downstream of the merge point for an acceleration lane.

   f. To accommodate bicyclists, a minimum effective clear shoulder width of 5 feet should be provided from the outside edge of the rumble strip groove to the outside edge of the paved shoulder (see Figure 2A), or 5 feet from the outside edge of the rumble strip groove to the front face of barrier (including curb) or guardrail. Rumble strips should be discontinued 50 feet before and started 50 feet after when adjacent to guardrail where there is less than 5 feet between the outside edge of the rumble strip and the face of the guardrail.

   g. If the above clear area cannot be maintained, then consider installing Bicycle-Friendly Edgeline Rumble *Stripes* within the painted edgeline. A Rumble Stripe is a milled rumble strip that is placed on the painted edgeline and the edgeline is repainted over the top of the milled rumble strip (see Figure 3). If no shoulder exists, the installation of Rumble *Stripes* should be considered. Rumble Stripes shall meet the longitudinal design of Bicycle-Friendly rumble strips.

   h. The Bicycle-Friendly Edgeline Rumble Strip pattern shall consist of 40-foot long segments of rumble strips with 12-foot segments of no rumble strips.

3. Two-Lane Conventional Roadways

   a. Bicycle-Friendly Edgeline Rumble Strips should be installed on all rural two-lane roadways with a minimum of 11 foot lanes, 5 foot shoulders, and a posted speed limit or 85th percentile speed of 40 miles per hour or higher.

   b. Bicycle-Friendly Edgeline Rumble Strips should be considered for installation on all other two-lane roadways if an engineering study determines that road departure crash rates along the section of roadway exceed statewide or national averages for similarly

classified roadways and if rumble strips are a viable crash reduction countermeasure for the particular roadway. DelDOT's Bicycle Coordinator should be notified prior to installation of edgeline rumble strips on any two-lane conventional roadway.

c. Bicycle-Friendly Edgeline Rumble Strips should be installed in accordance with the details provided in Figures 2A, 2B and 2C.

d. Rumble strips shall not be installed on bridge decks without approval from the DelDOT Bridge section.

e. Rumble strips are to be broken for all intersections and driveway entrances where the shoulder edgeline pavement markings tie into the driveway entrance or where the edgeline pavement markings are broken. The installation of rumble strips should be stopped 25 feet prior to the turn radius PC and restarted 25 feet after the turn radius PT.

f. Rumble strips should not be installed on acceleration, deceleration or bypass lanes, or two-way left turn lanes. Installation should stop 150 feet prior to the diverge point of a deceleration lane and should not commence until 150 feet downstream of the merge point for an acceleration lane.

g. Generally, continuous longitudinal rumble strips should not be applied on the shoulders of roadways within developed and urban areas. In suburban and developing areas, the designer should consult with Engineering Support to determine if noise will be a concern.

h. To accommodate bicyclists, a minimum effective clear shoulder width of 5 feet should be provided from the outside edge of the rumble strip groove to the outside edge of the paved shoulder (see Figure 2A), or 5 feet from the outside edge of the rumble strip groove to the front face of barrier (including curb) or guardrail. Rumble strips should be discontinued 50 feet before and started 50 feet after when adjacent to guardrail where there is less than 5 feet between the outside edge of the rumble strip and the face of the guardrail.

i. If the above clear area cannot be maintained, then consider installing Bicycle-Friendly Edgeline Rumble *Stripes* within the painted edgeline. A Rumble Stripe is a milled rumble strip that is placed on the painted edgeline and the edgeline is repainted over the top of the milled rumble strip (see Figure 3.) If no shoulder exists, the installation of Rumble *Stripes* should be considered. Rumble Stripes shall meet the longitudinal design of Bicycle-Friendly rumble strips.

j. The Bicycle-Friendly Edgeline Rumble Strip pattern shall consist of 40-foot long segments of rumble strips with 12-foot segments of no rumble strips.

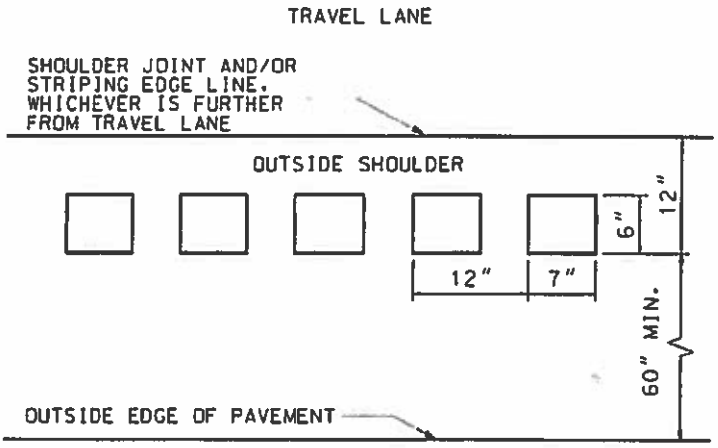


FIGURE 2A
BICYCLE-FRIENDLY EDGELINE RUMBLE STRIP DETAILS
NOT TO SCALE

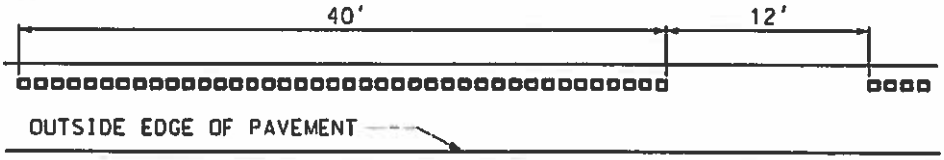


FIGURE 2B
BICYCLE-FRIENDLY EDGELINE RUMBLE STRIP SEGMENT DETAILS
NOT TO SCALE

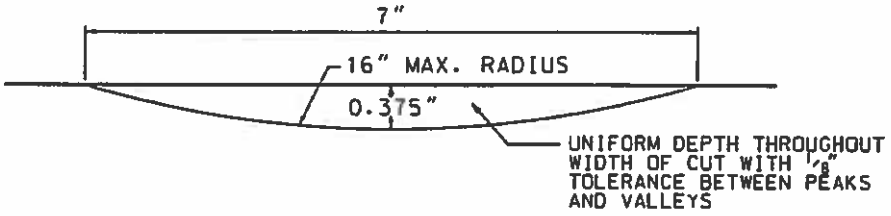


FIGURE 2C
RUMBLE STRIP SECTION – BICYCLE-FRIENDLY RUMBLE STRIPS
NOT TO SCALE

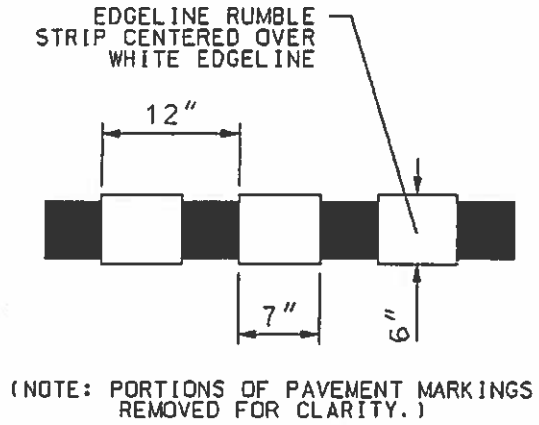
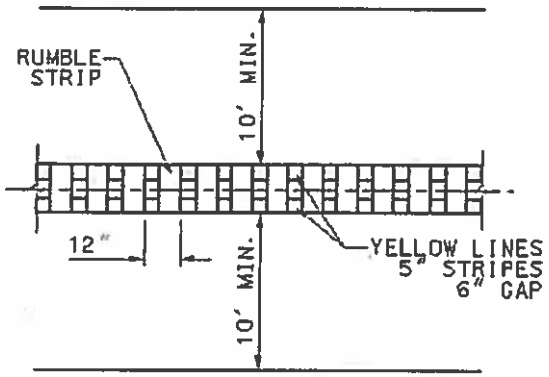


FIGURE 3
EDGELINE RUMBLE STRIPE DETAILS
NOT TO SCALE

B. Center Line Rumble Strips

1. Center line rumble strips should be considered on all conventional two-lane and undivided multilane roadways where an engineering study determines that crossover or head-on crash rates along the section of roadway exceed statewide or national averages for similarly classified roadways and if rumble strips are a viable crash reduction countermeasure. The study should be reviewed and approved by the Chief Traffic Engineer.
2. The installation of center line rumble strips shall be in accordance with Figures 4A and 4B. Center line rumble strips should start and end following the center line striping.
3. Center line rumble strips shall not be installed on bridge decks without approval from the DelDOT Bridge section.
4. In areas where the center line leads into a raised concrete island, the rumble strips should be discontinued 25' in advance of these islands.
5. In areas where the center line splits to create, for example a turn lane, the rumble strips should be placed only along the double yellow center line that is *not* forming the left turn lane. Should a back-to-back left turn lane scenario exist, center line rumble strips should follow the double yellow center line in accordance with Figure 4A.
6. On roads with recessed pavement markers (RPMs), center line rumble strips should begin one foot downstream of the RPM housing and terminate one foot upstream of the RPM housing, as shown in Figure 5.



(NOTE: PORTIONS OF PAVEMENT MARKINGS REMOVED FOR CLARITY.)

FIGURE 4A
CENTER LINE RUMBLE STRIP DETAILS
NOT TO SCALE

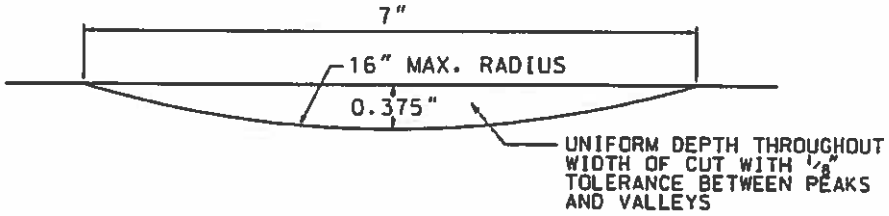
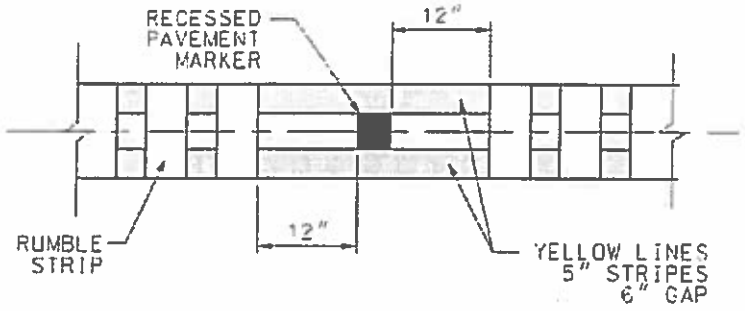


FIGURE 4B
CENTER LINE RUMBLE STRIP DETAILS
NOT TO SCALE



(NOTE: PORTIONS OF PAVEMENT MARKINGS REMOVED FOR CLARITY.)

FIGURE 5
CENTER LINE RUMBLE STRIP WITH RECESSED PAVEMENT MARKER DETAILS
NOT TO SCALE

C. Other Considerations

The composition of the new pavement section or the thickness, condition, and type of existing pavement needs to be determined prior to the application of milled rumble strips. The installation of milled rumble strips on pavement that is of questionable thickness, condition, or type (e.g. hot-mix over P.C.C. pavement) needs to be evaluated to ensure that the installation of the rumble strip will be possible without adverse impact to the pavement or the performance of the strip. The designer should contact the Materials and Research Section for existing pavement cores. If no core data is available, pavement cores should be obtained and the information reviewed with the Materials and Research Section.

For construction projects on roadways with existing rumble strips, the rumble strips should be eliminated if the temporary traffic control plans require traffic to be shifted onto the shoulder or crosses a center line. Longitudinal rumble strips should be relocated when traffic patterns are changed within long-term stationary work zones. The use of milled rumble strips within the temporary traffic control plan should be reviewed with the Traffic Safety Section.

This guidance and the figures herein do not account for all possible applications (e.g. rural gore areas). Therefore, it may be necessary for the designer to develop special application plans or details for the application of milled or alternative longitudinal rumble strip treatments. All such plans and details should be submitted to the Traffic Safety Section for review prior to their use on a project. This includes the use of center line rumble strips on two-way highways where additional factors such as lane width, total roadway width, etc. should be considered.

III. Justification

To improve safety by alerting inattentive drivers through vibration and sound with continuous longitudinal center line and/or edgeline rumble strips that their vehicles have left the travel lane. This safety countermeasure has shown proven results and is recommended as part of the State of Delaware Strategic Highway Safety Plan. A 2003 FHWA Delaware Division Office study revealed the benefit/cost ratio of the rumble strips installed on I-95 south of Wilmington in 1998 was approximately 7:1. The unit costs for the rumble strips on this project were $7.92 per foot. The price

of rumble strips has dropped significantly since this installation; in 2003 DelDOT paid 24 cents per foot for the installation of rumble strips along SR 1. If this had been the unit price for the I-95 project, the benefit/cost ratio would have been 212:1. A benefit to cost ratio for an installation of center line rumble strips along US 301 was determined to be 110:1.

Prepared by: Traffic Section
Revised: October 2, 2014

Recommended by: Assistant Director – Traffic — Date 11/14/14

Approved: Chief Engineer — Date 11/17/14

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