



# INDIANA DEPARTMENT OF TRANSPORTATION

*Driving Indiana's Economic Growth*

## Design Memorandum No. 19-01

February 8, 2019

**TO:** All Design, Operations, District Personnel, and Consultants

**FROM:** /s/ David Boruff  
David Boruff  
Manager, Office of Traffic Administration  
Traffic Engineering Division

**SUBJECT:** Rumble Strips and Rumble Stripes

**REVISES:** *Indiana Design Manual (IDM) Sections 45-1.02(06) and 502-2.09, 502-2.10(New), and Figures 502-2Q and 502-2R(New)*

**EFFECTIVE:** Lettings on or after March 1, 2019

Property owners adjacent to state highways have expressed concerns about the noise generated from rumble stripes. Compared to a traditional corrugation pattern, a sinusoidal corrugation pattern tends to generate less noise. INDOT evaluated various sinusoidal rumble strip widths, wavelengths, and milling depths as part of JTRP study SPR-4016, *Assessment of Alternative Sinusoidal Rumble Stripe Construction*. Based on the results, the rumble strip and rumble stripe standards have been modified to use a sinusoidal corrugation pattern with a 12-in. wavelength.

Effective with lettings on or after March 1, 2019, RSP 808-T-190, Longitudinal Rumble Stripes will be superseded by RSP 808-T-190, Pavement Corrugations, and RPD 808-T-190d, Longitudinal Rumble Stripe Details, will be superseded by RPD 808-T-190d, Pavement Corrugations and Rumble Stripe Details.

The referenced IDM sections have been revised and are included for reference on the following pages. Definitions and a summary of revisions are below.

**Pavement Corrugation.** A depression milled into the pavement, either a traditional (conventional) or a sinusoidal pattern, which provides a vibratory and auditory indication to drivers that they have left the travel lane. The traditional pattern is now designated as “conventional” for pay item purposes.

**Shoulder Corrugation.** A conventional pavement corrugation placed in the shoulder. Shoulder corrugations are used on two-lane and multi-lane undivided facilities with PCC pavement and on freeways and divided highways regardless of pavement type.

The shoulder corrugation design guidance has been deleted from IDM 45-1.02(06) and combined with the rumble strip and rumble stripe guidance in IDM 502-2.09.

**Shoulder Rumble Strip.** A sinusoidal pavement corrugation placed in the shoulder. Shoulder rumble strips are used only with HMA pavement.

Shoulder rumble strips are offset either 6 in. or 8 in. from the edge line; the 8 in. offset is used only if there will be a longitudinal shoulder joint. Details are shown in RPD 808-T-190d, Pavement Corrugations and Rumble Stripe Details, and will be incorporated into the 2019 Standard Drawings.

**Edge Line Rumble Stripe.** A sinusoidal pavement corrugation placed at the edge line with the longitudinal pavement marking recessed within it. The use of edge line rumble stripes is limited to two-lane facilities with HMA pavement. The use of a conventional corrugation pattern for a rumble stripe is at the discretion of the district Traffic Engineer and may be considered where noise is not a concern.

To facilitate the use of the shoulder by bicyclists

- The width of the edge line corrugation has been reduced from 16 in. to 12 in.
- The bicycle gap spacing has been adjusted from a 10 ft gap every 60 ft to a 12 ft gap every 60 ft.
- Bicycle gaps are now provided on all edge line rumble stripes where the paved shoulder width is at least 2 ft.

Details are shown in RPD 808-T-190d, Pavement Corrugations and Rumble Stripe Details, and will be incorporated into the 2019 Standard Drawings.

**Centerline Rumble Stripe.** A sinusoidal pavement corrugation placed at the centerline with the pavement marking recessed within. The use of centerline rumble stripes is limited to two-lane facilities with HMA pavement.

**Transverse Rumble Strips.** A set of raised pavement markings placed transversely across the travel lane. The marking material and profile are the same those used for temporary buzz strips; however, the placement is based on stopping sight distance or decision sight distance, as appropriate.

Guidance for using permanent transverse rumble strips has been added to IDM 502-2.10.

### **Pay items**

Separate pay items have been created to distinguish between the sinusoidal and conventional corrugation pattern. The sinusoidal corrugation pattern requires additional milling and has a higher unit cost than the conventional corrugation pattern. Longitudinal pavement markings used for rumble stripes should continue to be paid for separately.

Pay Item	Pay Item Description	Unit
606-12399	MILLED HMA CORRUGATIONS, CONVENTIONAL	LFT
606-12400	MILLED HMA CORRUGATIONS, SINUSOIDAL	LFT
606-11064	MILLED PCCP CORRUGATIONS, CONVENTIONAL	LFT

Questions regarding project specific rumble strip and rumble stripe design issues should be discussed with the appropriate district Traffic Engineer. Dave Boruff, Office of Traffic Administration Manager, [dboruff@indot.in.gov](mailto:dboruff@indot.in.gov), may be contacted with general questions.

ARCHIVED

## **45-1.02(06) Shoulder Corrugations [Rev. Feb. 2019]**

Shoulder corrugations guidance has been moved to Section 502-2.0 Pavement Markings.

...

## **502-2.09 Milled Longitudinal Pavement Corrugations [Rev. Feb. 2019]**

Milled longitudinal pavement corrugations, also known as longitudinal rumble strips in the *IMUTCD*, provide an audible and vibratory warning to a motorist leaving the travel lane. They are an effective means of reducing lane departures and may be specified in conjunction with a pavement resurface/reconstruction project or as a stand-alone project.

The use of pavement corrugations should be coordinated with the appropriate district Traffic Engineer.

### **502-2.09 (01) Pavement Corrugation Type [Add. Feb. 2019]**

The Department utilizes two milled corrugation patterns, conventional and sinusoidal. The sinusoidal corrugation pattern has been shown to reduce the amount of noise generated from vehicles travelling over the corrugation.

The pavement corrugation type – shoulder corrugation, shoulder rumble strip, and edge line or centerline rumble stripe – is based the corrugation pattern and the presence or absence of a longitudinal pavement marking within the corrugation. A general description of each type is below. See Section 502-2.09(02) for selection criteria.

1. Shoulder Corrugation. A shoulder corrugation is a milled conventional corrugation pattern used without a pavement marking and placed in the shoulder near the travel lane. Shoulder corrugations are used on rural two-lane and multi-lane undivided facilities with PCC shoulder pavement and on freeways and divided highways regardless of pavement type. The minimum paved shoulder width to utilize shoulder corrugations is 4 ft.

See INDOT *Standard Drawings* series E606-SHCG for conventional shoulder corrugations and corrugation limits (gaps).

2. Shoulder Rumble Strip. A shoulder rumble strip is a milled sinusoidal corrugation pattern used without a longitudinal pavement marking and placed in the shoulder near the travel lane. Shoulder rumble strips are used on rural two-lane and multi-lane

undivided facilities with HMA shoulder pavement. The minimum paved shoulder width to utilize shoulder rumble strips is 4 ft.

See RPD 808-T-190d, Pavement Corrugations and Rumble Stripe Details, for the sinusoidal corrugation pattern and breaks in corrugation limits (gaps) until the details are incorporated in the INDOT *Standard Drawings*.

3. Edge line and Centerline Rumble Stripe. A rumble stripe is a milled sinusoidal corrugation pattern with a longitudinal pavement marking installed within the corrugation. The use of a conventional corrugation pattern for a rumble stripe may be considered where noise is not a concern and is at the discretion of the district Traffic Engineer.

Rumble stripes are used on rural two-lane facilities with HMA pavement and placed at either the edge of the travel lane or the centerline. The milled sinusoidal corrugation should be quantified separately from the associated pavement marking.

See RPD 808-T-190d, Pavement Corrugations and Rumble Stripe Details, for the sinusoidal corrugation pattern and breaks in corrugation limits (gaps) until the details are incorporated in the INDOT *Standard Drawings*.

### **502-2.09 (02) Pavement Corrugation Type Selection [Rev. Feb. 2019]**

The designer should consider the roadway type and design criteria to determine whether to specify shoulder corrugations, shoulder rumble strips, rumble stripes, or combination thereof. Criteria that preclude the use of pavement corrugations are listed in item 3 below.

For the purposes of this determination, “rural” is a function of roadway characteristics and prevailing land use, not necessarily a location outside an urban area boundary.

See Figure 502-2Q, Pavement Corrugation Type Selection Summary, for an overview of the selection criteria.

When the pavement design selected is PCCP, only shoulder corrugations may be specified.

1. Selection by roadway type.
  - a. Rural Two-lane Facility
    - 1) Segment with posted speed limits  $\geq 50$  mph. Shoulder rumble strips or edge line or centerline rumble stripes should be specified based on lane and HMA

paved shoulder width. Shoulder corrugations should be specified for based on lane and PCCP paved shoulder width.

- 2) Segment with posted speed limits < 50 mph. Edge line rumble stripes, shoulder rumble strips, and shoulder corrugations generally should not be used, although special circumstances may justify their use, e.g., the presence of significant history of run-off-road crashes. Centerline rumble stripes are not applicable.

b. Rural Multi-lane Undivided Facility

- 1) Segment with posted speed limits  $\geq$  50 mph. Shoulder rumble strips and shoulder corrugations should be specified based on paved shoulder width and pavement type. Edge line and centerline rumble stripes are not applicable.
- 2) Segment with posted speed limits < 50 mph. Shoulder rumble strips and shoulder corrugations may be specified if special circumstances justify their use, e.g., the presence of significant history of run-off-road. Edge line and centerline rumble stripes are not applicable.

c. Rural Freeway, Interstate, or Divided Highway. Shoulder corrugations should be specified for rural freeways, interstates, and divided highways. Rumble strips, edge line and centerline rumble stripes are not applicable.

2. Design criteria for selecting corrugation type and combination of types. Where the combination of centerline and edge line rumble stripes or centerline rumble stripes and shoulder rumble strips is not viable, the use of only centerline rumble stripes should be specified. Where centerline rumble stripes alone are not viable, edge line rumble stripes alone or shoulder rumble strips alone should be specified.

a. Centerline and edge line rumble stripes in combination. The combination of centerline and edge line rumble stripes may be considered when the following criteria are met:

- 1) the posted speed limit is 50 mph or above; and
- 2) the design lane width is at least 11 ft; and
- 3) the design paved shoulder width is at least 2 ft but less than 4 ft.

b. Centerline rumble stripes and shoulder rumble strips in combination. The combination of centerline rumble stripes and should rumble strips may be considered when the following criteria are met:

- 1) the posted speed limit is 50 mph or above; and
  - 2) the design lane width is at least 11 ft; and
  - 3) the design paved shoulder width is at least 4 ft.
- c. Centerline rumble stripes only. Centerline rumble stripes alone may be considered when the following criteria are met:
- 1) the posted speed limit is 50 mph or above; and
  - 2) the design lane width is at least 10 ft but less than 11 ft.
- d. Edge line rumble stripes only. Edge line rumble stripes alone may be considered when the following criteria are met:
- 1) the posted speed limit is 50 mph or above; and
  - 2) the design paved shoulder width is at least 2 ft but less than 4 ft.
- e. Shoulder rumble strips only. Shoulder rumble strips alone may be considered when the following criteria are met:
- 1) the posted speed limit is 50 mph or above; and
  - 2) the design paved shoulder width is at least 4 ft.
3. Design criteria that preclude the use of pavement corrugations. Pavement corrugations should not be specified for new or reconstructed pavement or retrofitted on an existing pavement where the roadway segment has one or more of the following:
- a. Horse-drawn vehicles are known to regularly use the shoulder and shoulder width is less than 10 ft;
  - b. Pavement has a chip seal (seal coat) surface that is less than a year old;
  - c. Pavement has a surface treatment with an active warranty, e.g., Microsurface or ultrathin bonded wearing course (UBWC) are less than 3 years old.
  - d. Pavement is in poor condition as determined by the Division of Pavement Design or the district Pavement Engineer; or
  - e. Resurfacing is expected within the next 3 years; or
  - f. PCC pavement (precludes use of rumble strips and rumble stripes only).

Consultants should contact their project manager to obtain information regarding pavement warranties or district resurfacing project schedules.

### **502-2.09 (03) Corrugation Limits [Rev. Feb. 2019]**

1. Bicycle Gaps. To accommodate bicyclists, 12-ft longitudinal gaps are provided every 60 ft in edge line rumble stripes and shoulder rumble stripes.
2. Intersection and Turn Lane Gaps. Centerline rumble stripes and inside shoulder corrugations on divided roadways should be gapped where turn lanes are developed at intersections or where two-way left turn lanes are present.
3. Raised Pavement Markers (RPMs). Rumble stripes generally should not be used in combination with centerline or edge line RPMs, but rather used instead of RPMs. In special circumstances, RPMs may be specified with rumble stripes with approval from the district Traffic Engineer.

### **502-2.09 (04) Plan Details and Quantities [Rev. Feb. 2019]**

Shoulder corrugations, rumble strips, and rumble stripes should be shown on the Typical Section and Pavement Marking Details plan sheets. Shoulder corrugations and rumble strips are paid for a milled [pavement type] corrugations, conventional or sinusoidal, respectively. For rumble stripes, the milled corrugation and longitudinal pavement marking are paid for separately. In the case of a retrofit project, removal of existing lines is paid for separately.

### **502-2.10 Transverse Rumble Strips [Add. Feb. 2019]**

Transverse rumble strips are used to alert drivers to an unexpected traffic condition that is approaching. Transverse rumble strips typically consist of sets of raised pavement markings with the spacing as shown in Figure 502-2R. The marking material and profile are the same those used for temporary buzz strips. See INDOT *Standard Drawings* series 801-TCDV.

The use of more than two rumble strip sets is for situations where additional warning may be appropriate. The decision sight distance (DSD) may be used for the spacing of the rumble strip sets at particularly complex locations where the driver reaction time may exceed 2.5 seconds. Use of transverse rumble strips must be approved by the district Traffic Engineer.

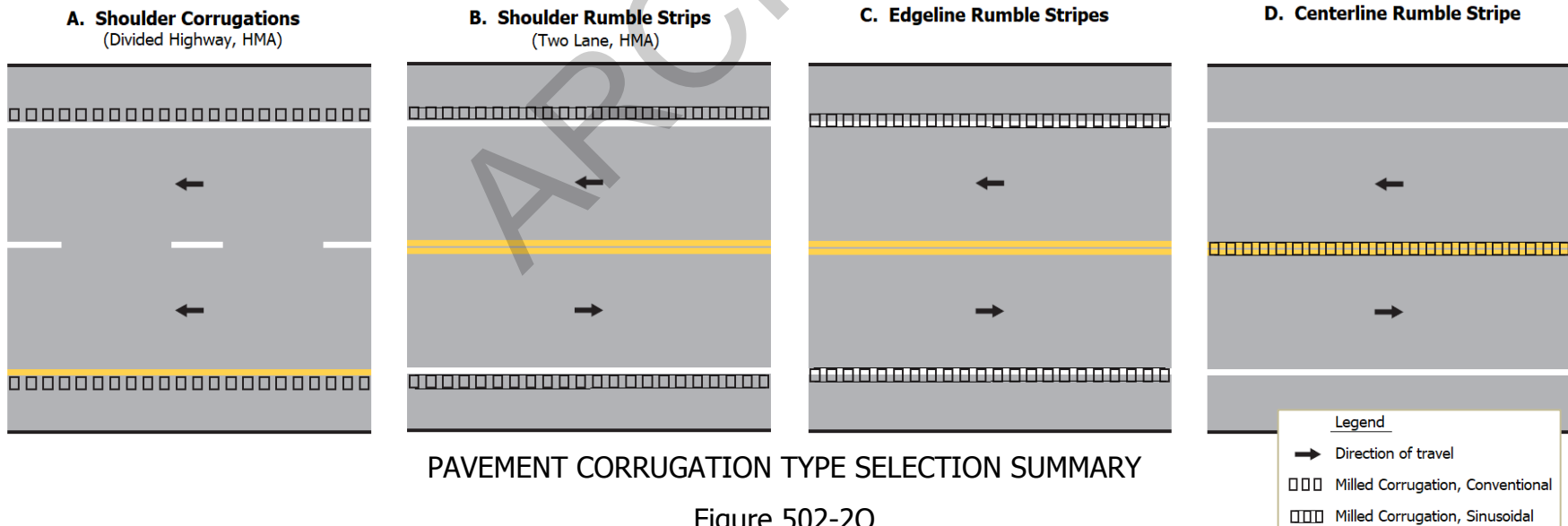
Noise can be an issue with transverse rumble strips. Alternative safety improvements should be considered if the location is close to a residential area.



Roadway Type	Rural Two-lane, Lane Widths ≥ 10' and < 11'		Rural Two-lane, Lane Widths ≥ 11' and ≤ 12', Paved Shoulder Width ≥ 2' and < 4'		Rural Two-lane, Lane Widths ≥ 11' and ≤ 12', Paved Shoulder Width ≥ 4'		Rural Multi-lane, Undivided, Paved Shoulder Width ≥ 4'		Rural Freeway, Interstate, or Divided Highway, Paved Shoulder Width ≥ 4'	
	HMA Pavement	PCC Pavement	HMA Pavement	PCC Pavement	HMA Pavement	PCC Pavement	HMA Pavement	PCC Pavement	HMA Pavement	PCC Pavement
Shoulder Corrugations (Conventional)						X		X	X	X
Shoulder Rumble Strip (Sinusoidal)					X		X			
Edge line Rumble Stripe (Sinusoidal)			X							
Centerline Rumble Stripe (Sinusoidal)	X		X		X					

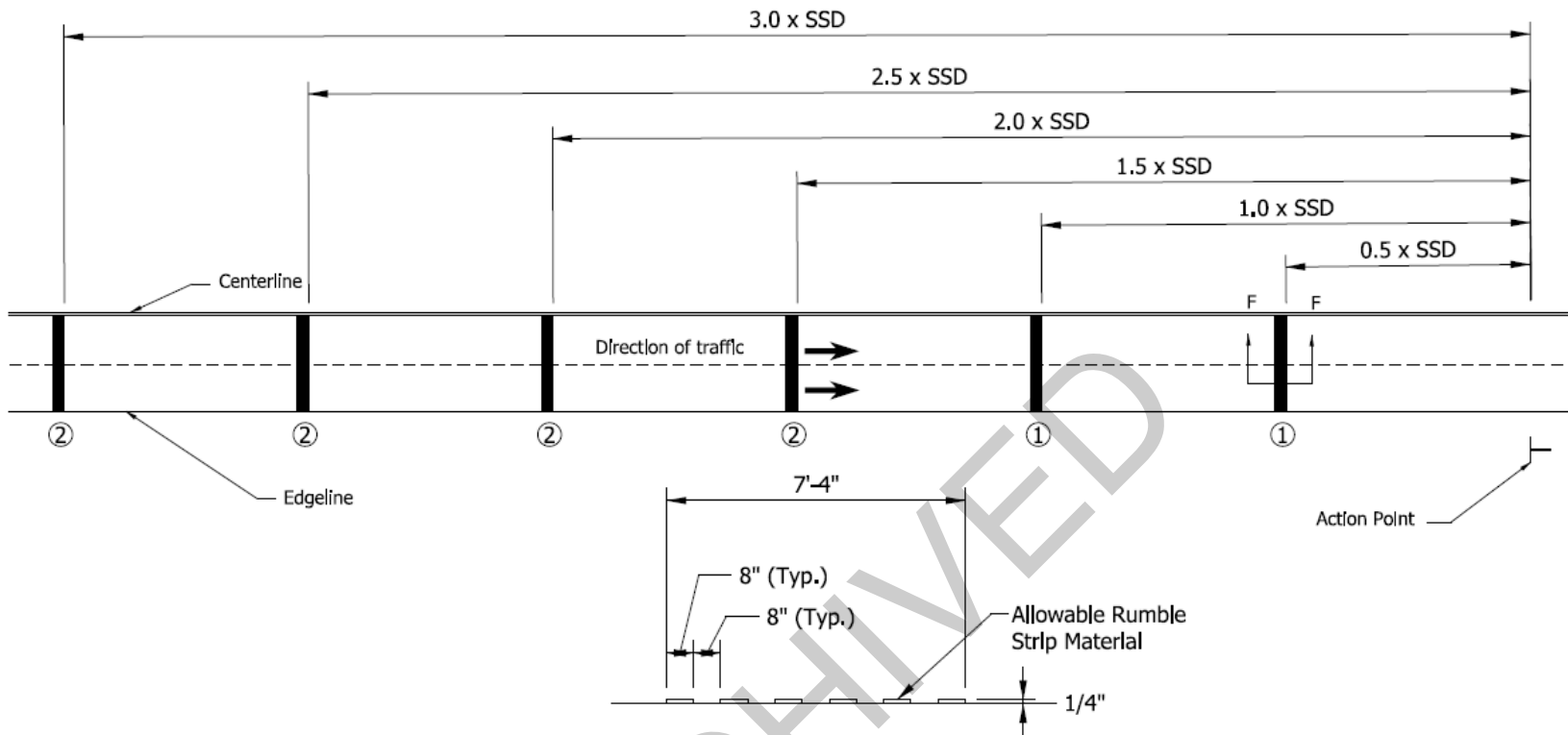
Notes:

1. The posted speed limit should be 50 mph or above. Use of pavement corrugations where the posted speed limit is less than 50 mph may be considered where special circumstances justify their use, e.g. crash history.
2. Centerline rumble stripes should not be used on multi-lane facilities.
3. Corrugations may not be installed on chip seal (seal coat) surfaces less than a year old or any pavement surface treatment such as microsurface or ultrathin bonded wearing course (UBWC) that is under an active warranty (i.e. less than 3 years old).
4. Pavement corrugations should not be considered where horse-drawn vehicles regularly use the shoulder.



PAVEMENT CORRUGATION TYPE SELECTION SUMMARY

Figure 502-2Q



**SECTION F-F  
(Typ.)**

**NOTES:**

- ① Basic rumble strip installation consists of two rumble strip sets, at the locations shown.
- ② Additional rumble strip set locations, install as directed by the district traffic engineer.
- ③ Decision Sight Distance (DSD) may be appropriate for some locations. For DSD, see IDM Chapter 42, Figure 42-2A.
4. For Stopping Sight Distance (SSD) see IDM Chapter 42, Figure 42-1A.

**TRANSVERSE RUMBLE STRIPS**

**Figure 502-2R**