

45-1.02(06) Shoulder Corrugations

Shoulder corrugations should be considered for a roadway designed as a rural *multi-lane* facility. *The designer should contact the District Technical Services Division to determine whether shoulder corrugations should be provided in lieu of edge line rumble stripes. See Section 76-3.02(06) for additional information on longitudinal rumble stripes.*

The minimum paved width for an outside shoulder to provide shoulder corrugations is 6 ft. When guardrail, concrete barrier railing, or another type of roadside barrier is adjacent to an outside shoulder, such minimum paved width is 7 ft. The minimum paved width to provide median shoulder corrugations is 4 ft.

Shoulder corrugations should be milled, without regard to the shoulder-pavement material.

76-3.02(05) Raised Pavement Markers (RPMs)

Snowplowable RPMs provide a supplemental method of delineation and are a positive position guidance device. They should not be used as a replacement for standard pavement markings or conventional roadside delineation. The INDOT *Standard Drawings* provide details on the placement and color locations for RPMs. In addition, the following placement considerations should be reviewed.

1. Location. Site selection should be based primarily on the need for additional alignment delineation specifically in an area of frequently inclement weather (e.g., fog, smoke, rain) and in an area of low roadway illumination. RPMs placement should be considered where vehicles are leaving the roadway, an area showing excessive wear of existing pavement markings, an area with excessive skid marks, interchange ramp, etc. *RPMs that supplement the centerline or edge line pavement markings may be considered for urban highways, rural multilane highways, and rural two lane highways when the factors described in items 4 and 5 below are present and they do not meet the criteria for rumble stripes in Section 76-3.02(06). Under special circumstances, RPMs that supplement the centerline or edge line rumble stripes may be used with approval from the District Traffic Engineer.*

RPMs that supplement lane lines should be considered for multi-lane highways when the factors described in items 4 and 5 below are present.

2. Pavement Life. RPMs should not be placed at a location that is scheduled for resurfacing or reconstruction within the next four years.
3. Illumination. RPMs may not be required at a location that is illuminated.
4. Traffic Volume. RPMs should be considered where AADT exceeds 2500 for a 2-lane roadway, or 6000 for a 4-lane roadway. On a lower-volume road, an engineering investigation should be conducted to determine whether RPMs are appropriate to supplement the standard traffic-control devices.

5. Spacing. The spacing for RPMs on a tangent section is 80 ft. Spacing for centerline RPMs used in conjunction with a no-passing zone may be reduced to 40 ft. Six RPMs at 40-ft spacing (240 ft) may be used in advance of and following a delineated no-passing zone. Consideration should be given to connecting two locations or zones of RPMs where the distance between them is less than 3000 ft. See the INDOT *Standard Drawings* for additional details for spacing at other locations.
6. Special Locations. RPMs should not be used exclusively with edge lines or gore markings. RPMs may be used at a pavement transition, one-way or narrow bridge, special channelization area, or where there is strong justification for installation of the devices.
7. Blue Retroreflectors. An RPM with blue retroreflectors should be specified where a fire hydrant is located within the roadway's right of way. Such an RPM should be specified only for a roadway where RPMs with yellow or white retroreflectors are to be installed.

The RPM should be placed at an approximately right angle to the fire-hydrant location. It should be a two-way marker visible in both directions of travel. It should be placed in addition to RPMs with yellow or white retroreflectors.

For a 3-lane roadway with a bidirectional left-turn lane, the RPM should be placed within the transverse limits of the yellow markings on the hydrant side of the bidirectional left turn lane.

For a roadway of 4 lanes or more, the RPM should be placed within the transverse limits of the lane-line marking nearest the fire hydrant, but should not be placed within the transverse limits of the pavement-edge line.

The locations of RPMs with blue retroreflectors should be shown on the plans. Quantities for such RPMs should therefore be incorporated into the quantities for other RPMs.

For a two-lane, two-way roadway, the RPM should be placed within the transverse limits of the center-line marking.

Local-public-agency (LPA) standards, if such exist, should be applied to a road under LPA jurisdiction. The District Traffic Engineer should be contacted to determine when an LPA's standards, if such exist, should apply on a Department-maintained route within the LPA's jurisdiction.

76-3.02(06) Longitudinal Rumble Stripes

A rumble stripe is the combination of milled corrugations with the longitudinal pavement marking line installed within. This combination provides improved retroreflectivity of the pavement marking and an audible and vibratory warning to a motorist leaving the travel lane. Rumble stripes are a supplemental means of reducing lane departures and may be specified with a new pavement surface project or in a stand-alone rumble stripe retrofit project. The decision to specify rumble stripes as part of a project should be confirmed by the District Technical Services Division.

When determining whether to specify rumble stripes the designer should consider the roadway type first. When rumble stripes should be specified based on roadway type, the presence of design elements that may preclude the use of rumble stripes should be checked. For the purposes of determining the need for rumble stripes the designation of rural or urban is a function of roadway characteristics and prevailing land use, not necessarily a location outside or inside an urban area boundary.

1. *Selection by roadway type.*

a. *Rural two-lane and multi-lane undivided roads.*

- (1) *Segment with posted speed limits ≥ 50 mph. Centerline and edge line rumble stripes should be specified.*
- (2) *Segment with posted speed limits < 50 mph. Centerline or edge line rumble stripes generally should not be specified, although special circumstances may justify their use, e.g. the presence of significant history of run-off-road, opposite direction side swipe, and head-on crashes.*

b. *Rural multi-lane divided non-freeways.*

- (1) *Segment with posted speed ≥ 50 mph. Centerline rumble stripes are not applicable. Edge line rumble stripes may be specified on the inside or outside shoulders, or on both sides. Among other factors in this design decision is past traffic safety performance.*
- (2) *Segment with posted speed < 50 mph. Centerline rumble stripes are not applicable. Edge line rumble stripes generally should not be used, although special circumstances may justify its use.*

c. *Rural freeway (interstate or non-interstate). Edge line rumble stripes generally should not be specified. Centerline rumble stripes are not applicable.*

2. *Design elements that preclude rumble stripes.* *Should the combination of centerline and edge line rumbles stripes not be viable the designer should specify the use of only centerline rumble stripes. When centerline rumble stripes alone are not viable then edge line rumble stripes alone should be specified.*

a. *Centerline and edge line rumble stripes in combination. Centerline and edge line rumble stripes should not be used in combination when one or more of the following design elements are present:*

- (1) *the posted speed limit is less than 50 mph;*

- (2) *the design lane width is less than 11 ft;*
 - (3) *the design paved shoulder width is less than 2 ft;*
 - (4) *urban segment or a segment with a two-way left turn lane;*
 - (5) *chip seal (seal coat) surface within 1 year of surface application;*
 - (6) *pavement surface treatment with an active warranty, e.g. Microsurface or ultrathin bonded wearing course (UBWC) within 3 years of construction;*
 - (7) *rural segment with significant bicycle traffic and paved shoulder width is less than 4 ft; or*
 - (8) *rural segment where horse drawn vehicles are known to regularly use the shoulder and shoulder width is less than 10 ft.*
- b. *Centerline rumble stripes only. Centerline rumble stripes alone are not normally used when one or more of the following design elements are present:*
- (1) *the posted speed limit is less than 50 mph;*
 - (2) *the design lane width is less than 10 ft;*
 - (3) *urban segment or a segment with a two-way left turn lane;*
 - (4) *chip seal (seal coat) surface within 1 year of surface application; or*
 - (5) *pavement surface treatment with an active warranty e.g. Microsurface or UBWC within 3 years of construction.*
- c. *Edge line rumble stripes only. Edge line rumble stripes alone are not normally used when one or more of the following design elements are present:*
- (1) *the posted speed limit is less than 50 mph;*
 - (2) *the design paved shoulder width is less than 2 ft;*
 - (3) *urban segment;*
 - (4) *chip seal (seal coat) surface within 1 year of surface application;*
 - (5) *pavement surface treatments with an active warranty e.g. Microsurface UBWC within 3 years of construction;*
 - (6) *rural segment with significant bicycle traffic and paved shoulder width is less than 4 ft; or*

- (7) *rural segment where horse drawn vehicles are known to regularly use the shoulder and shoulder width is less than 10 ft.*
- d. *Retrofitted Rumble Stripes. Rumble Stripes should not be retrofitted on an existing pavement when an applicable design element noted above exists or when one or more of the following design elements are present:*
- (1). *the existing pavement condition is poor as determined by the Division of Pavement Design or the District Pavement Engineer;*
 - (2). *along any segment that will be resurfaced within the next 3 years; or*
 - (3). *the section is under a pavement warranty that has not expired. Contact the District Pavement Engineer or see the INDOT intranet site for information on warranty sections:
<http://intranet.indot.state.in.us/pdf/PavementPreservationWarrantyDates.pdf>
Consultants may contact their project manager to obtain this information.*

Rumble stripes generally should not be used in combination with centerline and edge line RPMs, but rather used instead of. In special circumstances RPMs may be specified with rumble stripes with approval from the District Traffic Engineer.

Unless directed by the District Traffic Engineer, thermoplastic should not be specified with longitudinal rumble stripes

INDOT Standard Specifications and Drawings provide details on the installation of rumble stripes. As shown on the Standard Drawings, the centerline and the edge line markings will be installed within the corrugation. Centerline corrugations should be gapped where turn lanes are developed at intersections or where two-way-left turn lanes are present. For centerline rumble stripes, the milled corrugations should follow the centerlines around channelizing islands or medians

The plans should show the rumble stripes with the pavement marking details. When edge line rumble stripes are included but no shoulder joint is present the typical cross sections of the plans should also show the location the new edge of traveled pavement. Separate payment should be made for the pavement markings, the milled corrugations, and in the case of a retrofit project, for the removal of existing lines.