

REVISED INTERIM DRAFT

# Guidelines for Application of Rumble Strips and Rumble Stripes

February 11, 2010



## I. INTRODUCTION

### A. PURPOSE

The intent of these guidelines is to establish SHA's policy on the proper use and application of longitudinal rumble strips (shoulder and centerline), transverse rumble strips, and rumble stripes on Maryland's highway system. These guidelines consolidate MSHA's Draft *Directive and Guidance on the Use of Longitudinal Rumble Strips* (date Revised May 14, 2002), *Use of Temporary Transverse Rumble Strips in Work Zones* (SHAs Work Zone Safety Toolbox) and new information into a single document.

### B. TARGET USERS

State Highway Administration (SHA) staff/engineers, consultants, and local government agencies.

## II. DEFINITIONS

***Rumble Strips:*** Rumble Strips are raised or grooved patterns on the roadway or shoulder that provide audible and vibratory warnings to drivers that their vehicles are leaving the driving lane or are approaching an unusual or unexpected traffic or road condition.

***Shoulder Rumble Strips:*** Shoulder rumble strips are located along the shoulder to alert road users that they are leaving the travel lanes.

***Centerline Rumble Strips:*** Centerline rumble strips are rumble strips with centerline pavement markings applied over top of the rumble strips. They warn drivers whose vehicles are crossing centerlines to avoid potential crashes with opposing traffic or run off the road to the left crashes.

***Transverse Rumble Strips:*** Transverse rumble strips extend across the travel lane to alert drivers to unusual traffic conditions.

***Applied Rumble Strips:*** Rumble strips that are created by placing pavement marking tape or other product on the roadway surface.

***Milled or Ground Rumble Strips:*** Rumble strips that are created by milling or grinding depressions into the pavement surface (either Hot Mix Asphalt or Portland Cement Concrete).

***Rumble Stripes:*** Rumble Stripes are created by placing edgeline pavement markings over top of shoulder rumble strips.

### **III. POTENTIAL APPLICATIONS**

This document provides guidance on where and how to install rumble strips and rumble stripes. Except in unusual circumstances as determined by engineering judgment, these devices should be installed in accordance with this guidance. In addition to the guidelines described herein, implementation of rumble strips should conform to the applicable guidelines in the MdMUTCD section 6F.84.

#### **A. SHOULDER RUMBLE STRIPS**

Shoulder rumble strips may be used along roadways with shoulders to warn motorists that they are leaving the travel lanes.

##### **1. Expressways and Controlled-Access Highways**

Shoulder rumble strips should be installed along the inside and outside shoulders of expressways and controlled access highways, with the following exceptions:

- An expressway or controlled-access highway having a posted speed limit of 40 mph or less.
- An expressway or controlled-access highway where an engineering study finds that the installation of shoulder rumble strips is not feasible (e.g., because of shoulder width or condition), the potential safety benefits of rumble strips likely cannot be realized, or that other considerations outweigh the potential safety benefits of rumble strips
- The shoulder is designated for use by buses or for other travel
- As otherwise precluded in these guidelines

Shoulder rumble strips may be installed along the beltways and expressways/controlled-access highways inside the beltways with written concurrence of the District Engineer.

##### **2. Other Highways**

Shoulder rumble strips should be installed along the inside and outside of other divided highways, and along the outside shoulder of undivided highways where the posted speed limit is 40 mph or greater, except as otherwise precluded in these guidelines.

Unless an extraordinary circumstance exists, shoulder rumble strips should not be installed along highways where the posted speed limit is less than 40 mph.

##### **3. Roadways Where Bicycles are Permitted**

Along expressways where bicycles are expressly permitted to travel and along other highways where shoulder rumble strips are desirable, the accommodation of bicyclists must be considered. The following apply to these highways:

*Shoulder Widths*

- Where the paved outside shoulder is five feet or greater in width, rumble strips are to be installed in accordance with the typical shown in Section IV.A. of this document.
- Where the outside shoulder is less than five feet in width:
  - The installation of rumble strips is to be coordinated with the Bicycle Coordinator within the Office of Planning and Preliminary Engineering, who will provide the needed coordination with the Bicycle and Pedestrian Advisory Committee.
  - Consideration should be given to the need for and benefit of installing minimum width rumble strips (lateral length), minimum depth rumble strips, and/or placed closer to the edge of the roadway.
  - Consideration should be given to the need for and benefit of installing rumble stripes.
- Roadway corridors with segments that have deficient shoulder widths should not preclude the use of shoulder rumble strips for the entire corridor. Deficient shoulders are defined as shoulders where the lateral distance from the outside edge of the rumble strip to the outside edge of the shoulder is less than 4 feet or to the face of traffic barrier is less than 5 feet. In these segments rumble strips should not be installed for the length that the deficient shoulder exists. In determining the minimum clear width, consideration should be given to decreasing the width of the rumble strips and/or placing them closer to the roadway edge, and the use of rumble stripes.
- Shoulder widths should be based on actual field measurements and not on reliance of widths shown on plans, as-builts, or inventories.

*Gaps*

- No gaps for bicyclists are to be provided along highways where the posted speed limit is 55 mph or greater.
- Although safety is maximized by continuous rumble strips, for highways where the posted speed limit is less than 55 mph, gaps for bicyclists shall be installed.
- Gaps should be installed with a 60-foot pattern (12-foot gap following a 48-foot length of rumble strips). This pattern can be adjusted to accommodate specific milling equipment or for other sound reasons; however, the gap should not be less than 8 feet nor greater than 12 feet and gaps should not be spaced less than 36 feet or more than 60 feet apart.

**Additional Guidance and Consideration**

- Noise from rumble strip hits should be considered when determining whether to install rumble strips and rumble stripes near residential areas or other sensitive



receptors. This should be a secondary consideration to safety. *(The National Cooperative Highway Research Program (NCHRP) has hired Midwest Research Institute to conduct a study entitled “Guidance for the Design and Application of Shoulder and Centerline Rumble Strips.” Several unresolved issues with installing either centerline or shoulder rumble strips will be addressed including “noise produced by rumble strips on adjacent residents.” The study began in July 2005 and was completed in June 2007. A survey was conducted of state transportation agencies to rank concerns regarding installation of rumble strips. Although the exact scope of the study has not been determined, based on conversations with the lead investigator at Midwest Research Institute, noise produced by rumble strips ranked highly and will likely be investigated in detail.)*

- Rumble strips and rumble stripes should not be installed where the surface condition is inadequate for their installation or, except for unusual circumstances, where resurfacing or other work that would substantially decrease the effectiveness of the strips is anticipated within the next two years.
- Rumble stripes may be installed in lieu of shoulder rumble strips with the concurrence of the Director, Office of Traffic and Safety, the District Engineer, and the Director, Office of Maintenance. See Section III.E. for further discussion of Rumble Stripes.
- More experienced bicyclists have expressed desire to ride between the edgeline and the rumble strip to avoid debris that commonly collects along the shoulders to the right of the rumble strip. Keeping the shoulders reasonably free from debris through periodic brooming and by the prompt removal of disabled vehicles (within the limits of Maryland law) will promote proper shoulder usage by bicyclists (i.e. riding to the right of the rumble strip).

## **B. CENTERLINE RUMBLE STRIPS**

Centerline rumble strips may be installed along an undivided highway with a 40 mph or greater posted speed limit and 10 foot or greater lane widths in a generally rural area where an engineering study has determined that their installation will improve safety. Other less invasive measures should be tried before rumble strip installation is recommended. Factors that may indicate a need for centerline rumble strips include:

- A high rate or number of head-on or run off the road to the left crashes
- A high number or rate of crashes involving fatigued drivers
- High volumes that increase the probability of head-on or run off the road to the left crashes

Centerline rumble strips should NOT be installed:

- In the area of intersections with public roads. Centerline rumble strips should be stopped 25 to 50 feet (25 feet for lower speed roadways and up to 50 feet for

higher speed roadways) in advance of the point of curvature of intersections or at the beginning of the taper for the left-turn lane.

- In areas with a high density of access points or in areas with short distances between access points

Installation of centerline rumble strips requires the written concurrence of the District Engineer.

### **Additional Guidance and Consideration**

- Centerline rumble strips may be installed in passing zones; however, the noise impacts to residential areas nearby should be considered.

### **C. TRANSVERSE RUMBLE STRIPS**

Transverse rumble strips may be used to attract the driver's attention to unexpected conditions or to bring the driver's attention to other warning devices. Transverse rumble strips may be considered for the following conditions:

#### **1. Approaches to Intersections (Signalized, Stop Controlled, Roundabouts)**

Transverse rumble strips should be considered on the approaches to intersections where there is a demonstrated safety problem (e.g. high crash rate), adequate trial of other warning devices has failed to reduce the crash frequency, and any of the following conditions exist:

- Inadequate stopping sight distance or signal/sign visibility
- Intersection is at an unexpected location
- Intersection is located where motorists have not been required to stop for a long period of time or distance

#### **2. Approaches to Horizontal Curves**

Transverse rumble strips should be considered on the approaches to horizontal curves where there is a demonstrated safety problem (e.g. high crash rate), adequate trial of other warning devices has failed to reduce the crash frequency, and any of the following conditions exist:

- A significant speed reduction from the posted speed limit is required to safely traverse the curve
- Curve is located at an unexpected location

#### **3. Approaches to Reduced Speed Zones**

Transverse rumble strips should be considered on the approaches to reduced speed zones where an engineering study finds that excessive speeding is a problem in a reduced speed zone and adequate trial of other regulatory devices has failed to reduce the occurrence of speeding. Factors that may indicate a need include:

- Posted speed reduction of 20 mph or greater

- Entrance to a town, business district, or location where significant pedestrian activity is anticipated
- The character of the roadway changes, such as at the end of a freeway

#### **4. Approaches to Toll Plazas**

Transverse rumble strips should be considered on the approaches to Toll Plazas where motorists are required to stop or slow to pay a toll.

#### **5. Approaches to Work Zones**

Transverse rumble strips may be used in work zones in advance of detours, flaggers, lane splits, crossovers, lane transitions, exit only lanes, lane closures, temporary traffic signals, and locations with major reductions in speed limits. Transverse rumble strips are not generally used for short-term maintenance related construction. When installed on a temporary basis, rumble strips should be sufficiently durable to cover the period of need. When temporary rumble strips are no longer needed, they should be removed from the pavement and the pavement should be cleaned and restored to normal conditions.

### **Additional Guidance and Consideration**

- Other less invasive measures should be tried before transverse rumble strips are recommended.
- Transverse rumble strips should be used with care at locations with high bicycle and motorcycle traffic.
- Transverse rumble strips should not be placed on roadways used by bicyclists unless a minimum clear path of 4 feet is provided at each edge of the roadway or each paved shoulder as described in AASHTO's "Guide to the Development of Bicycle Facilities."
- Transverse rumble strips may be supplemented with additional pavement marking warning messages such as "STOP AHEAD" or "SIGNAL AHEAD" where the purpose of the rumble strips may not be clear.
- The use of transverse rumble strips near residential areas or other sensitive noise receptors should be carefully evaluated.
- Transverse rumble strips should not be placed on sharp horizontal or vertical curves.
- The use of transverse rumble strips in shoulders to deter motorists from traveling in the shoulder for long distances where there is specific justification for their installation requires the written concurrence of the Director, Office of Traffic and Safety and the Director, Office of Maintenance. Transverse rumble strips should not be installed in shoulders where bicycle activity is anticipated.

**D. RUMBLE STRIPS BETWEEN LANES**

With specific justification and the concurrence of the Director, Office of Traffic and Safety and the Director, Office of Maintenance, rumble strips may be installed between adjacent lanes moving in the same direction at the following locations:

- Where there is a need to further discourage prohibited lane changing
- Between the through lanes and collector/distributor lanes where there is no physical barrier

**E. RUMBLE STRIPES**

For expressways and controlled-access highways that do not have shoulders or shoulders wide enough for shoulder rumble strips, rumble stripes may be installed. For all other highways that do not have shoulders or shoulders wide enough for both shoulder rumble strips and bicycle use (48" min.), rumble stripes may be installed.

Rumble stripes may be installed along a highway with a 40 mph or greater posted speed limit and 11 foot or greater lane widths in a generally rural area where an engineering study has determined that their installation will improve safety. Other less invasive measures should be tried before rumble stripe installation is recommended. Factors that may indicate a need for rumble stripes include:

- A high rate or number of run off the road crashes
- A high number or rate of crashes involving fatigued drivers
- High volumes that increase the probability of run off the road crashes

Rumble stripes should NOT be installed:

- In the area of intersections with public roads. Rumble stripes should be stopped 25 to 50 feet (25 feet for lower speed roadways and up to 50 feet for higher speed roadways) in advance of the point of curvature of intersections or at the beginning of the taper for the turn lanes.
- In areas with a high density of access points or in areas with short distances between access points

Installation of rumble stripes requires the written concurrence of the Director, Office of Traffic and Safety, the District Engineer, and the Director, Office of Maintenance.

## **IV. DESIGN GUIDELINES**

The following guidelines apply to the design and installation of all rumble strips and rumble stripes:

- Milled or ground rumble strips and rumble stripes are not to be installed on Portland Cement Concrete bridge decks or on Portland Cement Concrete bridge approach slabs.
- Milled or ground rumble strips and rumble stripes can be used on new or existing pavement. To retrofit rumble strips and rumble stripes on existing pavement, the pavement should be in sufficiently good condition to effectively accept the milling process without raveling or deteriorating. Otherwise the pavement should be upgraded prior to milling any desired rumble strips and rumble stripes.
- To the extent practicable, rumble strips and rumble stripes should avoid in-surface vehicle detectors and their leads, other highway wiring, raised pavement markers (RPMs), other traffic control devices, and other highway appurtenances.

### **A. SHOULDER RUMBLE STRIPS**

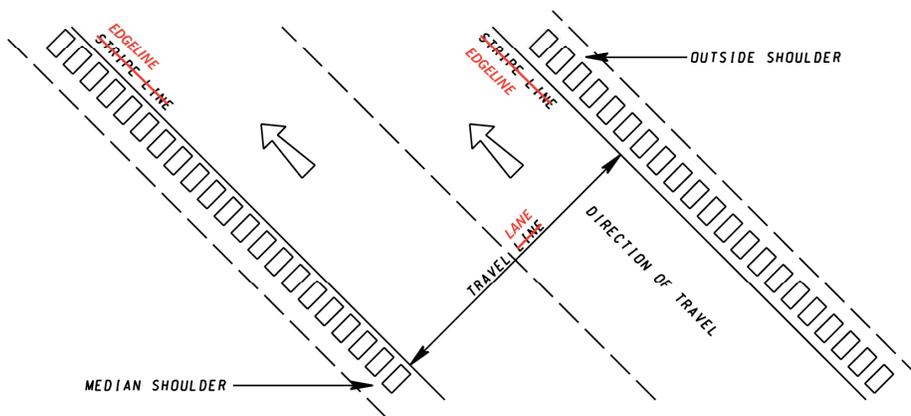
Shoulder rumble strips are to be milled or ground into the pavement surface. With the concurrence of the Director, Office of Traffic and Safety and the Director, Office of Maintenance, applied shoulder rumble strips may be used on an experimental basis.

Shoulder rumble strips and rumble stripes are to be installed in accordance with the details and typical shown in the following figures.

- Figure 1 – Revise Standard No. MD 670.00
- Figure 2 – Delete Standard No. MD 670.01, and replace with Typical No. 1
- Figure 3 – Revise Standard No. MD 670.02
- Figure 4 – New Typical for Right Side Shoulder Rumble Strip Details (Typical No. 1)
- Figure 5 – New Typical for Left Side Shoulder Rumble Strip Details (Typical No. 2)
- Figure 6 – New Typical for Rumble Stripe Details (Typical No. 3)
- Figure 7 – New Typical for Shoulder Rumble Strip and Rumble Stripe Details (Typical No. 4)



- TYPICALS
- A. SEE ~~STD MD 670.01~~ FOR ~~RUMBLE STRIP~~ DETAILS
  - B. 6" - 12"
  - C. ~~TRAVEL LANE STRIPE LINE~~  
EDGE LINE



**EXPRESSWAYS**  
**PLAN VIEW - DIVIDED HIGHWAY**

**NOTES**

1. THE RUMBLE STRIPS ARE FOR USE ON NEW OR EXISTING ASPHALT OR CONCRETE SHOULDERS. THE PATTERN IS DESIGNED SO THAT IT CAN BE MILLED OR GROUND INTO THE SHOULDER. SEE SPECIFICATIONS.
2. THE LEADING EDGE OF A RUMBLE STRIP SHOULD NOT BE CLOSER THAN 6" TO ANY JOINT, TRANSVERSE OR LONGITUDINAL, IN CONCRETE SHOULDERS.
3. ~~IF SHOULDER WIDTH IS 4 FT. OR LESS, RUMBLE STRIPS ARE TO BE PLACED 6" FROM EDGE OF TRAVEL LANE STRIPE. FOR SHOULDER WIDTHS GREATER THAN 4 FT RUMBLE STRIPS ARE TO BE 12" FROM TRAVEL LANE STRIPE.~~

SPECIFICATION <b>610</b>	CATEGORY CODE ITEMS	<b>Maryland Department of Transportation</b> <b>STATE HIGHWAY ADMINISTRATION</b> STANDARDS FOR HIGHWAYS AND INCIDENTAL STRUCTURES  <b>LOCATION OF SHOULDER</b> <b>RUMBLE STRIPS</b>  <b>STANDARD NO. MD 670.00</b>	
APPROVED <i>K. G. McCall</i> DIRECTOR - OFFICE OF HIGHWAY DEVELOPMENT			
	APPROVAL • SHA REVISIONS	APPROVAL • FEDERAL HIGHWAY ADMINISTRATION	
	APPROVAL <b>2-10-04</b>	APPROVAL <b>3-31-04</b>	
	REVISED	REVISED	
	REVISED	REVISED	

Figure 1 – Revisions to Standard No. MD 670.00

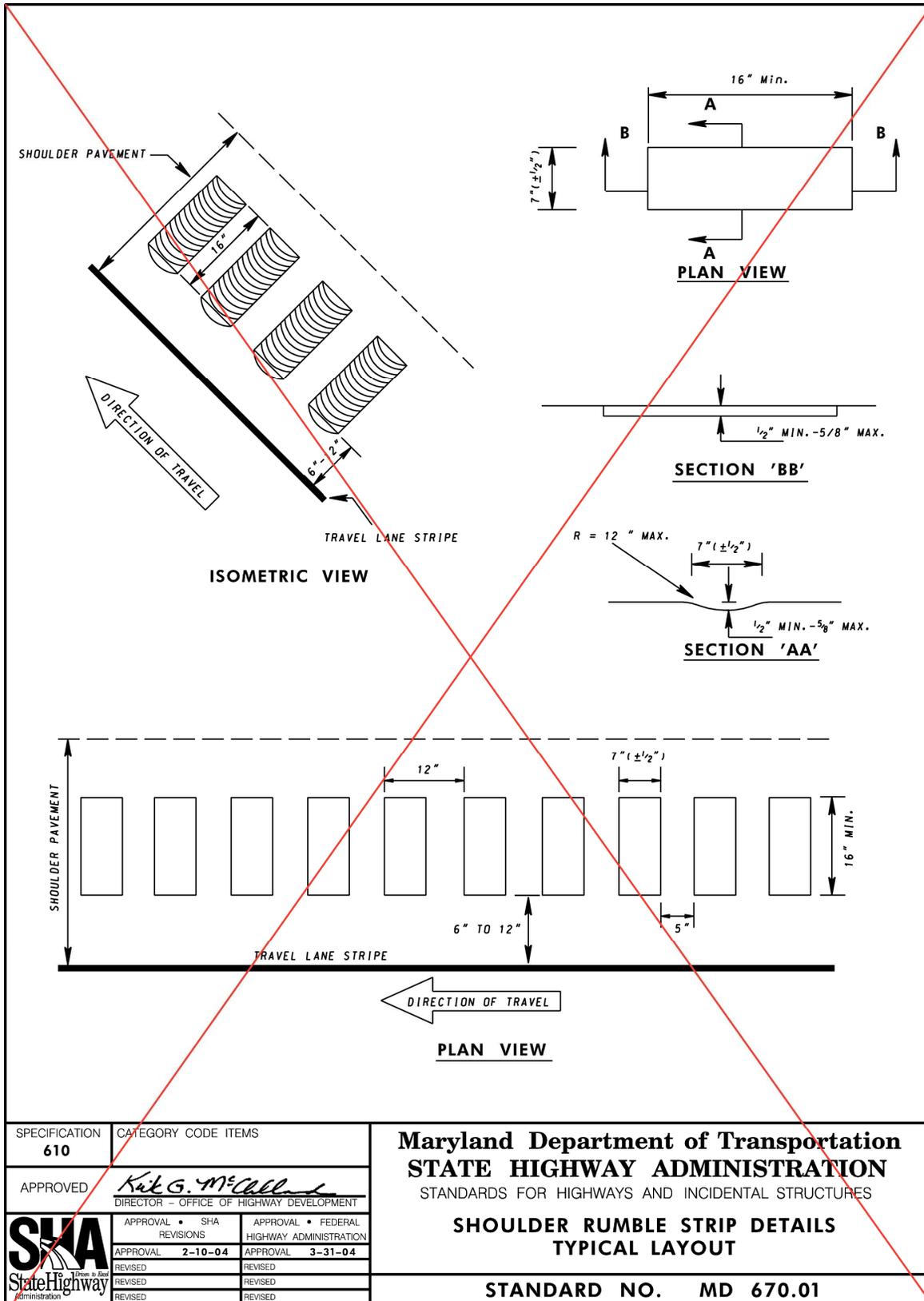
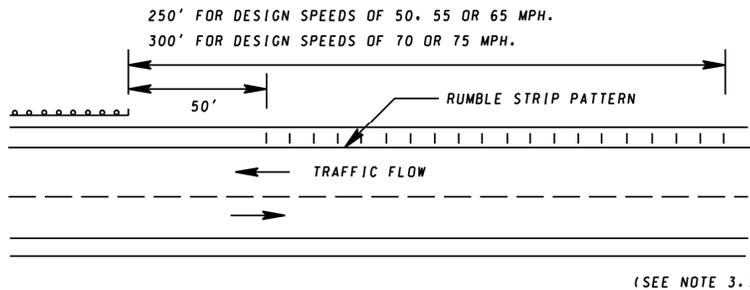
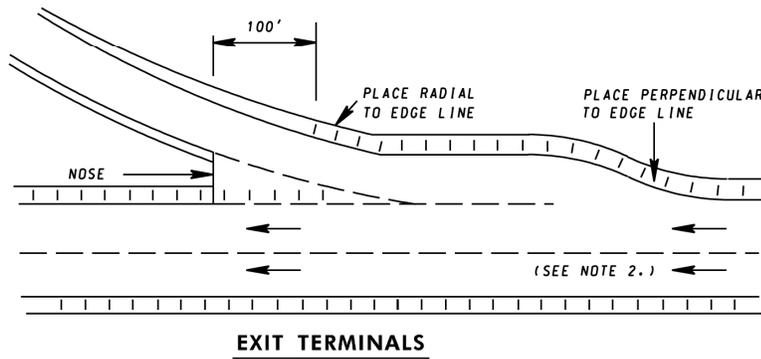
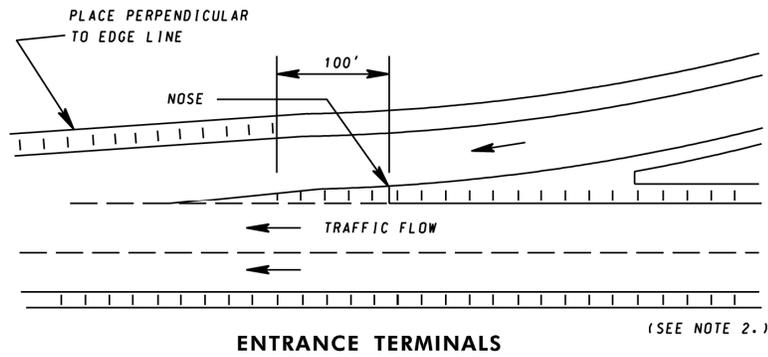


Figure 2 – Delete Standard No. MD 670.01



**NOTES**

TYPICALS

- SEE ~~CONSTRUCTION DRAWING STD MD 670-01~~ FOR RUMBLE STRIP DETAILS.
- AT ENTRANCE AND EXIT TERMINALS, THE OUTSIDE SHOULDER PATTERN SHOULD BE EXTENDED TOWARD THE RAMP JUNCTURE AS FAR AS POSSIBLE, AND THEN SHIFTED OVER TO THE OUTSIDE SHOULDER OF THE TERMINAL AREA. THE "NOSE" OF AN ENTRANCE OR EXIT TERMINAL IS A LOGICAL REFERENCE POINT. ON EITHER TERMINAL EXTEND THE PATTERN 100' INTO THE TERMINAL AREA AND THEN TRANSFER TO THE OUTSIDE SHOULDER.
- RUMBLE STRIPS, WHEN USED IN ADVANCE OF CRITICAL LOCATIONS, SUCH AS APPROACHES TO NARROW BRIDGES, IN GORE AREAS, AND AHEAD OF TRAFFIC BARRIER END TREATMENTS, SHOULD BE PLACED AS SHOWN.

SPECIFICATION <b>610</b>	CATEGORY CODE ITEMS	<b>Maryland Department of Transportation</b> <b>STATE HIGHWAY ADMINISTRATION</b> STANDARDS FOR HIGHWAYS AND INCIDENTAL STRUCTURES <b>LOCATION OF SHOULDER</b> <b>RUMBLE STRIPS AT</b> <b>CRITICAL LOCATIONS</b> <b>STANDARD NO. MD 670.02</b>
APPROVED	 DIRECTOR - OFFICE OF HIGHWAY DEVELOPMENT	
 State Highway Administration	APPROVAL • SHA REVISIONS	APPROVAL • FEDERAL HIGHWAY ADMINISTRATION
	APPROVAL 2-10-04	APPROVAL 3-31-04
	REVISED	REVISED
	REVISED	REVISED

Figure 3 – Revise Standard No. MD 670.02

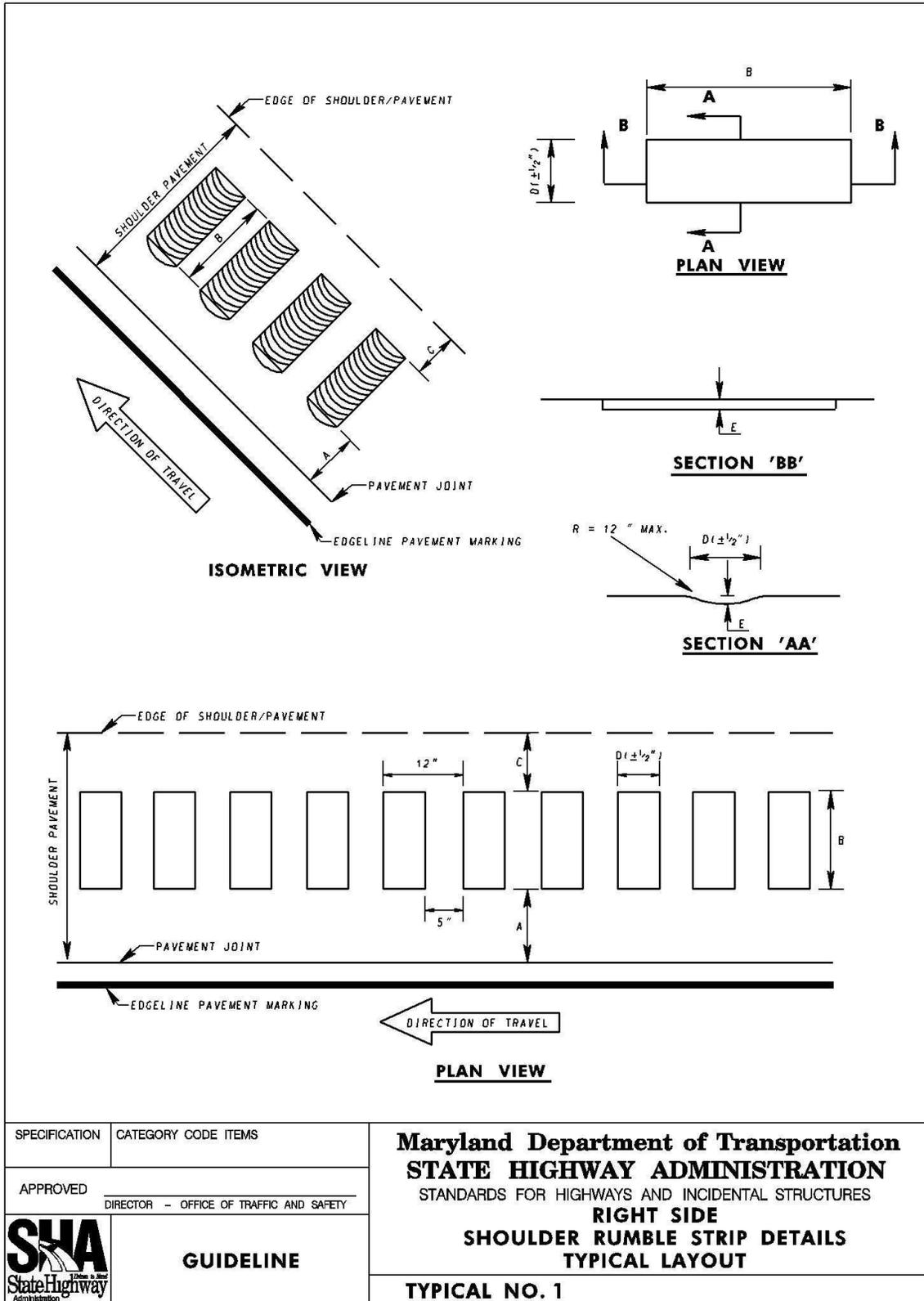


Figure 4 – New Typical for Right Side Shoulder Rumble Strip Details (Typical No. 1)

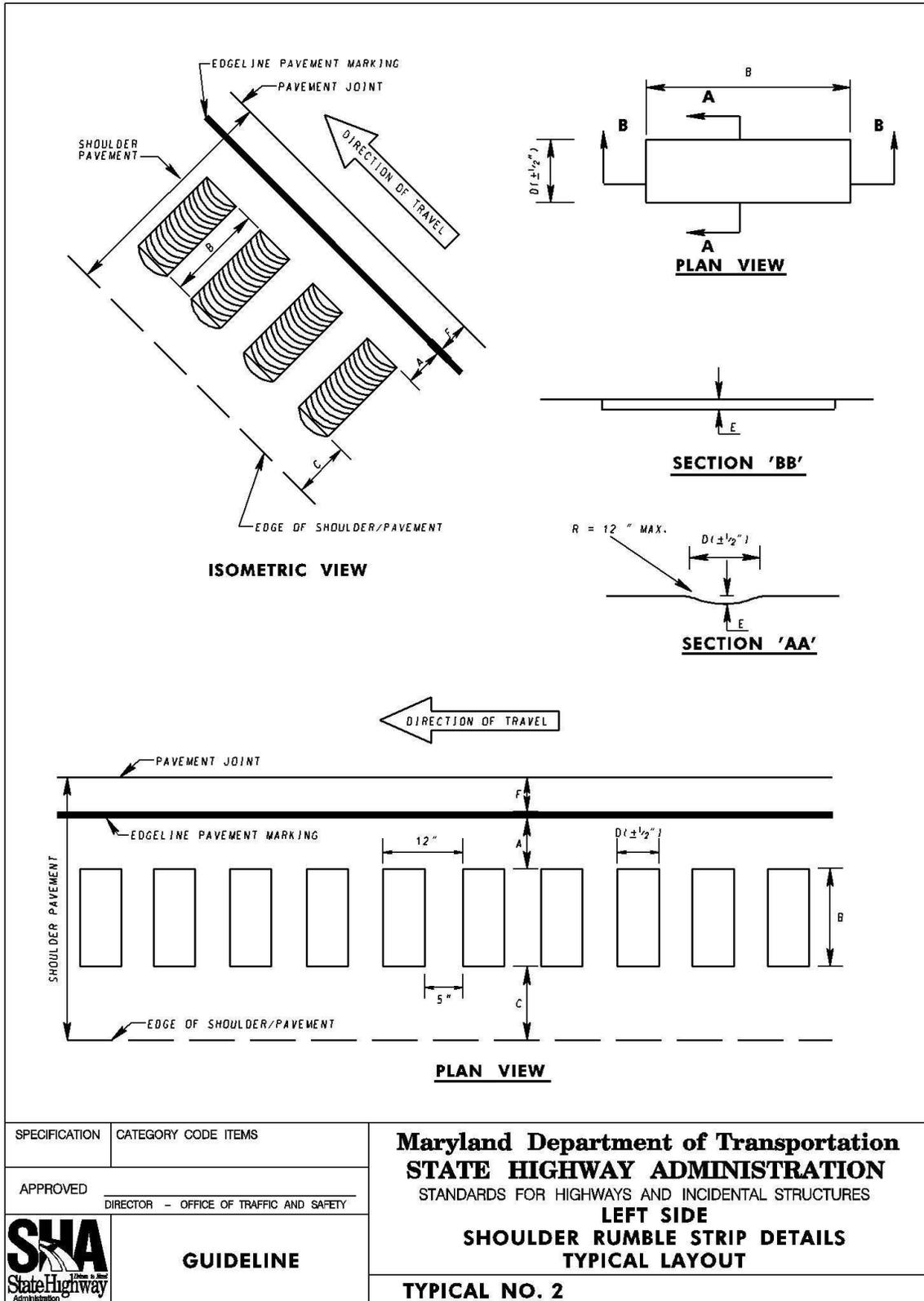


Figure 5 – New Typical for Left Side Shoulder Rumble Strip Details (Typical No. 2)

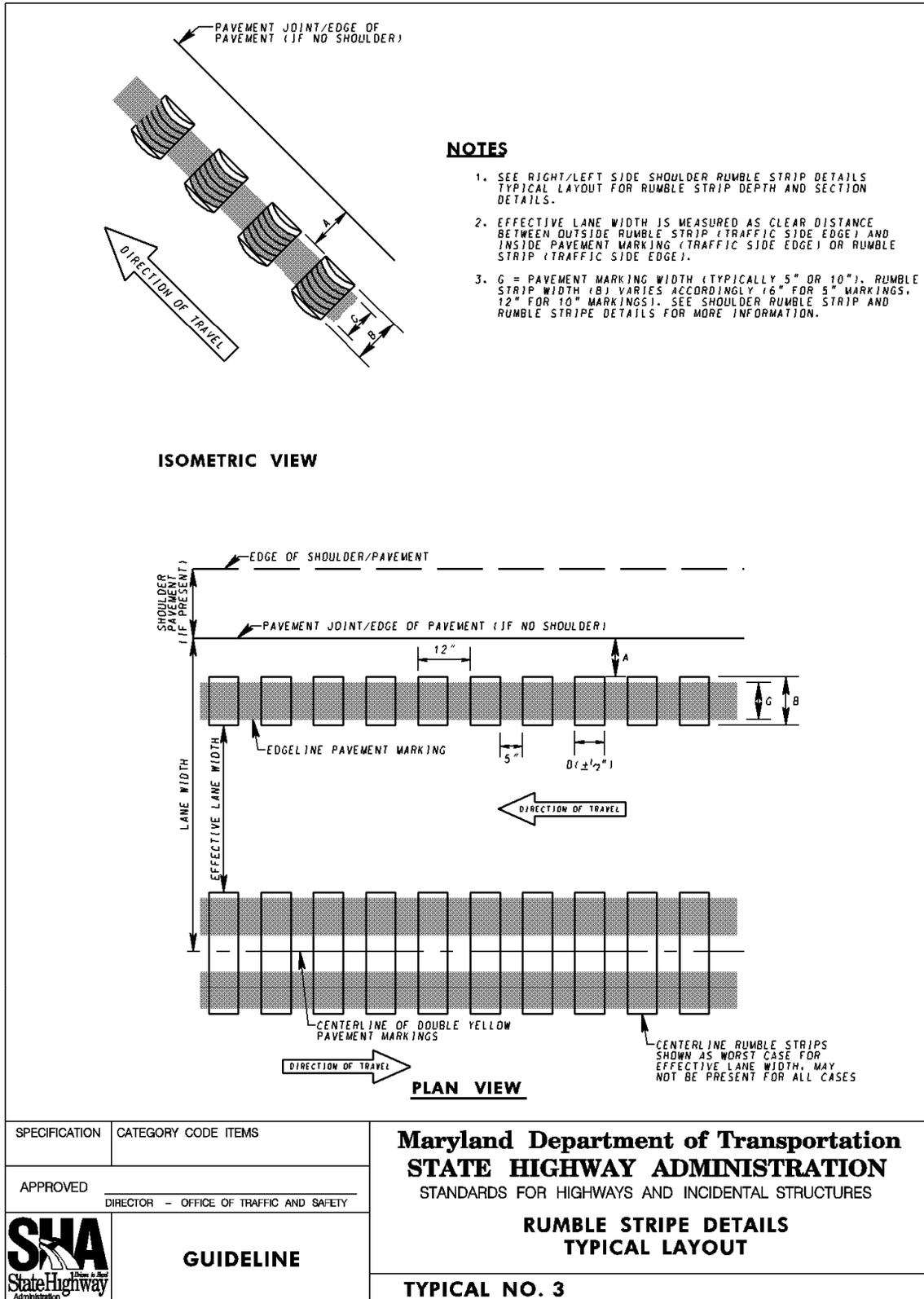


Figure 6 – New Typical for Rumble Stripe Details (Typical No. 3)

<b>RIGHT SIDE SHOULDER RUMBLE STRIP APPLICATION</b>						
ROADWAY TYPE	OFFSET FROM PAVEMENT JOINT TO RUMBLE STRIP	RUMBLE STRIP WIDTH	OFFSET FROM RUMBLE STRIP TO EDGE OF SHOULDER/ PAVEMENT	RUMBLE STRIP LENGTH	RUMBLE STRIP DEPTH	MINIMUM SHOULDER PAVEMENT WIDTH
	A	B	C	D	E	
EXPRESSWAYS (POSTED SPEED GREATER THAN OR EQUAL TO 55 MPH)	6" MIN. 12" MAX.	12" MIN. 16" STD.	6" TO 12" MIN.	7"	1/2" MIN. 5/8" MAX.	VARIES 24" TO 40"
ALL OTHER HIGHWAYS (POSTED SPEED LESS THAN 55 MPH AND GREATER THAN 40 MPH)	6" MIN. 12" MAX.	6" MIN. 12" STD.	<b>48" MIN. REQUIRED</b>	5" MIN. 7" STD.	3/8" MIN. FOR 5" LENGTH 1/2" MIN. - 5/8" MAX. FOR 7" LENGTH	VARIES 60" TO 72"

<b>LEFT SIDE SHOULDER RUMBLE STRIP APPLICATION</b>							
ROADWAY TYPE	OFFSET FROM PAVEMENT MARKING TO RUMBLE STRIP	RUMBLE STRIP WIDTH	OFFSET FROM RUMBLE STRIP TO EDGE OF SHOULDER/ PAVEMENT	RUMBLE STRIP LENGTH	RUMBLE STRIP DEPTH	OFFSET FROM PAVEMENT JOINT TO PAVEMENT MARKING	MINIMUM SHOULDER PAVEMENT WIDTH
	A	B	C	D	E	F	
EXPRESSWAYS (POSTED SPEED GREATER THAN OR EQUAL TO 55 MPH)	6" MIN. 12" MAX.	12" MIN. 16" STD.	6" TO 12" MIN.	7"	1/2" MIN. 5/8" MAX.	1" MIN. 2" STD.	VARIES 30" TO 52"
ALL OTHER DIVIDED HIGHWAYS (POSTED SPEED LESS THAN 55 MPH AND GREATER THAN 40 MPH)	6" MIN. 12" MAX.	6" MIN. 12" STD.	6" TO 12" MIN.	5" MIN. 7" STD.	3/8" MIN. FOR 5" LENGTH 1/2" MIN. - 5/8" MAX. FOR 7" LENGTH	1" MIN. 2" STD.	VARIES 24" TO 48"

<b>RUMBLE STRIPE APPLICATION</b>					
ROADWAY TYPE	OFFSET FROM PAVEMENT JOINT TO RUMBLE STRIP	RUMBLE STRIP WIDTH	RUMBLE STRIP LENGTH	RUMBLE STRIP DEPTH	EFFECTIVE LANE WIDTH
	A	B	D	E	
EXPRESSWAYS (POSTED SPEED GREATER THAN OR EQUAL TO 55 MPH)	6" STD.	6" FOR MARKINGS 5" MARKINGS 12" FOR 10" MARKINGS	7"	1/2" MIN. 5/8" MAX.	<b>9'-4" MIN. REQUIRED</b>
ALL OTHER HIGHWAYS (POSTED SPEED LESS THAN 55 MPH AND GREATER THAN 40 MPH)	6" STD.	6" FOR MARKINGS 5" MARKINGS 12" FOR 10" MARKINGS	5" MIN. 7" STD.	3/8" MIN. FOR 5" LENGTH 1/2" MIN. - 5/8" MAX. FOR 7" LENGTH	<b>9'-4" MIN. REQUIRED</b>

SPECIFICATION	CATEGORY CODE ITEMS	<p><b>Maryland Department of Transportation</b>  <b>STATE HIGHWAY ADMINISTRATION</b>                  STANDARDS FOR HIGHWAYS AND INCIDENTAL STRUCTURES  <b>SHOULDER RUMBLE STRIP                  AND RUMBLE STRIPE                  DETAILS</b></p>
APPROVED	_____ DIRECTOR - OFFICE OF TRAFFIC AND SAFETY	
 <p><b>GUIDELINE</b></p>		
		<b>TYPICAL NO. 4</b>

Figure 7 – New Typical for Shoulder Rumble Strip and Rumble Stripe Details (Typical No. 4)

Where it is determined that gaps in shoulder rumble strips are required to accommodate bicycles (see Section III.3.), gap spacing should be installed as shown in Figure 8. Gaps in rumble stripes should be considered where appropriate or necessary to accommodate bicycles (i.e. areas with shoulders less than 4' in width being used by bicyclists), gap spacing should be installed as shown in Figure 8.

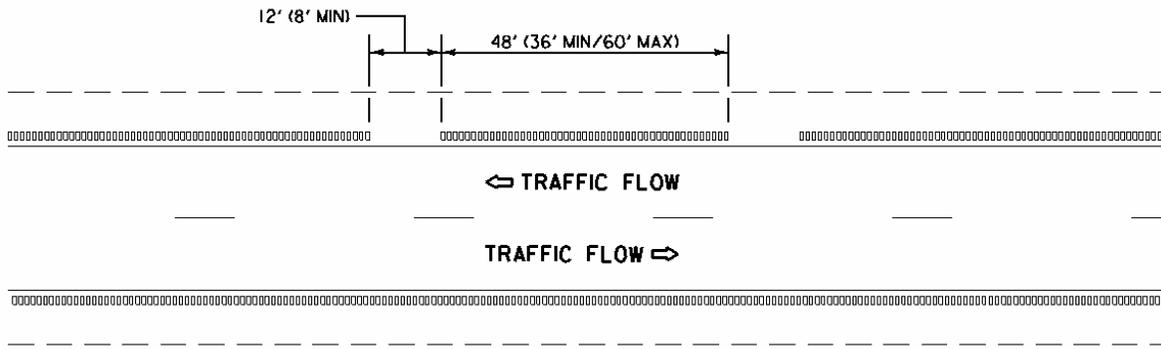


Figure 8 – Gap Spacing for Shoulder Rumble Strips and Rumble Stripes

In roadway segments with deficient shoulder widths (defined as shoulders where the lateral distance from the outside edge of the rumble strip to the outside edge of the shoulder is less than 4 feet or to the face of traffic barrier is less than 5 feet) rumble strips should not be installed for the length that the deficient shoulder exists as shown in Figure 9.

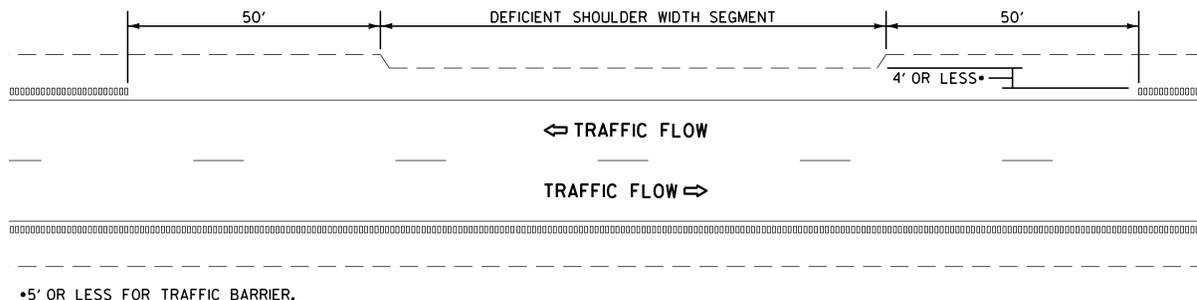


Figure 9 – Shoulder Rumble Strips In Areas with Deficient Shoulder Widths

**B. CENTERLINE RUMBLE STRIPS**

Centerline rumble strips are to be milled or ground into the pavement surface with pavement marking material applied over top. With the concurrence of the Director, Office of Traffic and Safety and the Director, Office of Maintenance, applied centerline rumble strips may be used on an experimental basis.

Installation of centerline rumble strips should be coordinated with permanent pavement marking and RPM placement. Permanent pavement markings and RPMs should be installed after installation of the rumble strips is complete. Liquid applied pavement marking materials such as, thermoplastic or paint shall be used for centerline markings in conjunction with centerline rumble strips.

Centerline rumble strips should be spaced along the centerline of a roadway as shown in Figure 10. Installation of raised pavement markers (RPMs) with centerline rumble strips as shown in Figure 10 is optional.

Centerline rumble strips should be stopped 25 to 50 feet (25 feet for lower speed roadways and up to 50 feet for higher speed roadways) in advance of the point of curvature of intersections or at the beginning of the taper for the left-turn lane.

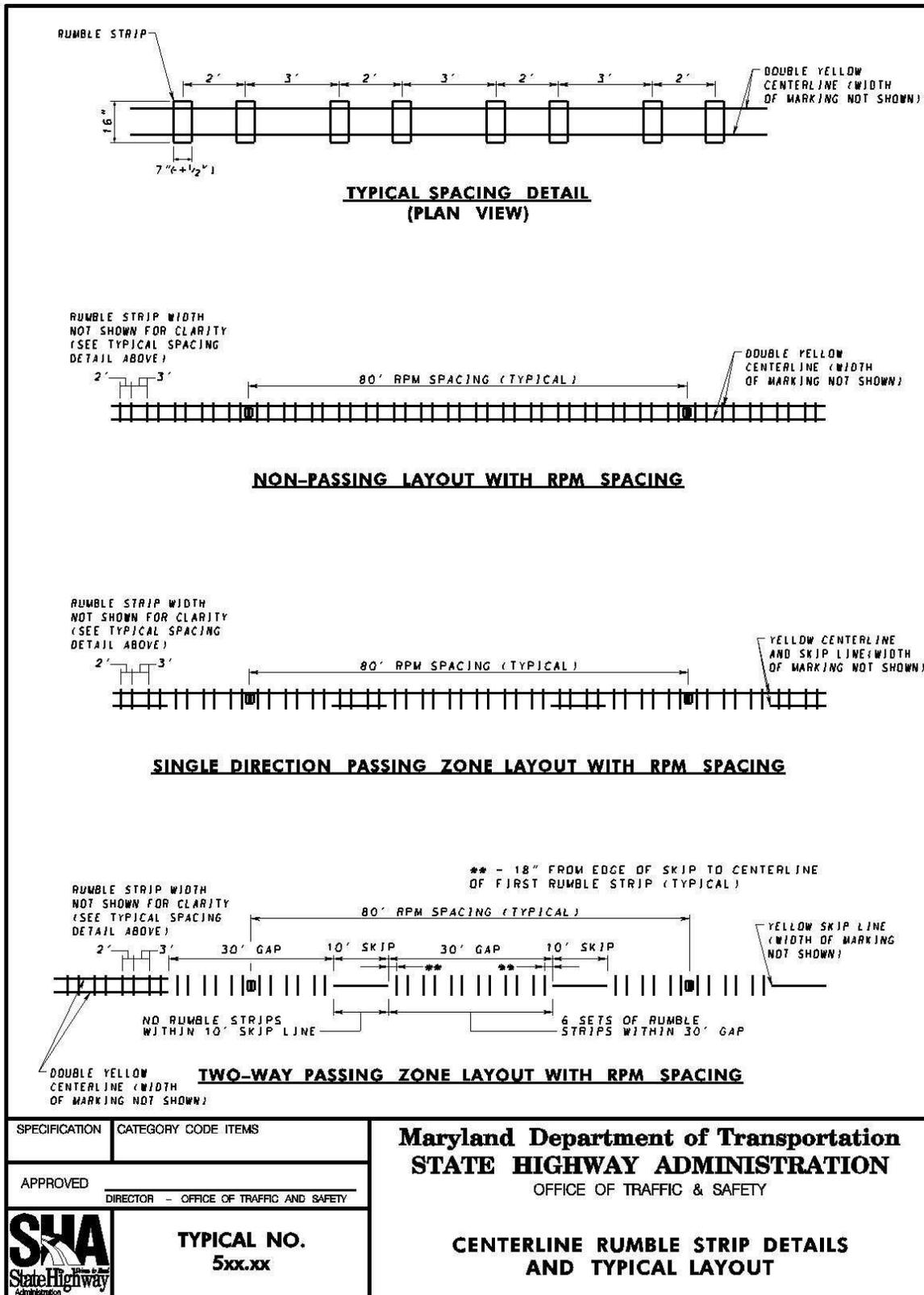


Figure 10 – Centerline Rumble Strips Details and Typical Layout

**C. TRANSVERSE RUMBLE STRIPS**

Transverse rumble strips are to be applied to the pavement surface with pavement marking material. Milled or ground transverse rumble strips may be used with the concurrence of the Director, Office of Traffic and Safety and the Director, Office of Maintenance. The guidelines described herein are applicable to applied transverse rumble strips.

Applied transverse rumble strips are created by placing two pieces of preformed pavement marking material on top of each other to obtain the desired thickness. Options include:

- placing a 10” pavement marking strip on the pavement and then a 5” pavement marking strip on top of the 10” pavement marking strip
- placing two 5” pavement marking strips on the pavement applied on top of each other (more aggressive application)

Figure 11 shows an example of the recommended placement of applied transverse rumble strips on the approach to a "Stop Ahead" sign. The "STOP AHEAD" pavement markings and the two sets of rumble strips located after the "Stop Ahead" sign are optional. This same application could be used prior to other warning signs including "Signal Ahead", "Yield Ahead", "Roundabout Ahead", "Reduced Speed Ahead", and other traffic control devices.

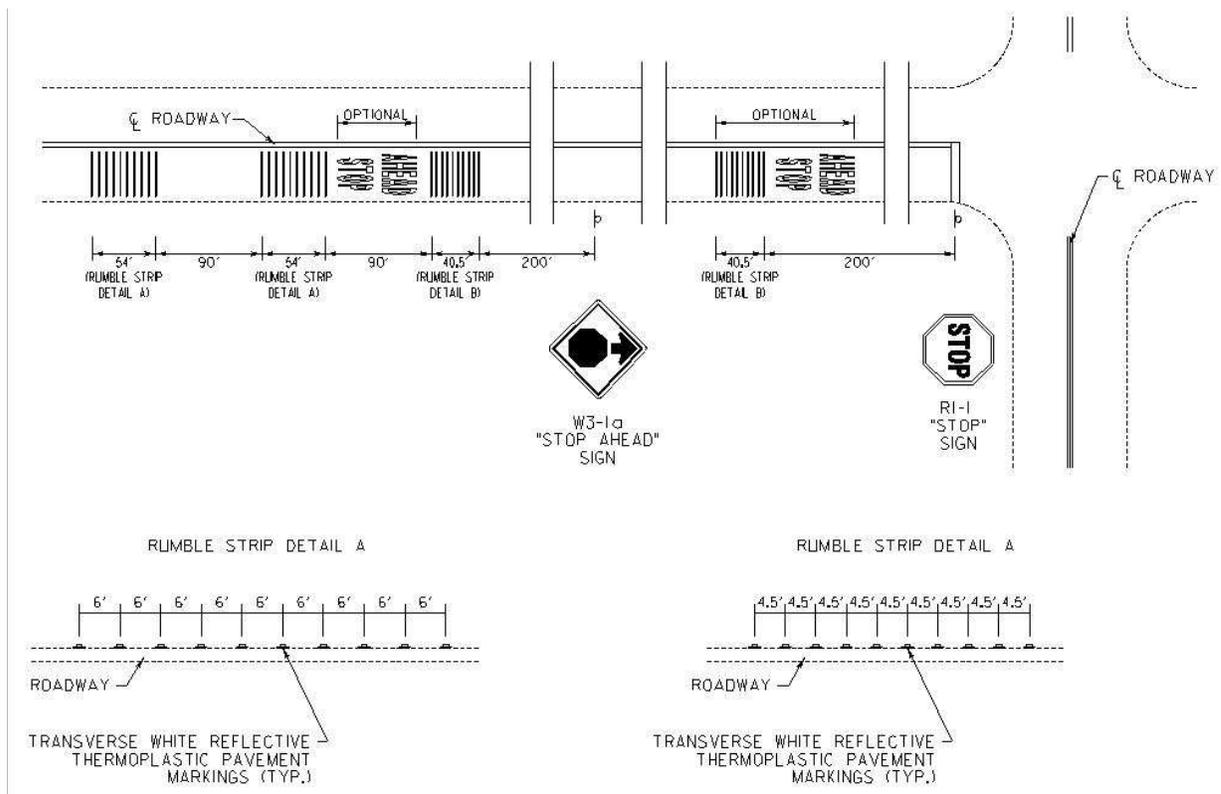


Figure 11 –Transverse Rumble Strip Placement

#### **D. RUMBLE STRIPS BETWEEN LANES**

The specific design (width, spacing, lateral placement, etc.) of rumble strips to be installed between lanes should be selected based on the identified problems and specific traffic, roadway, and area conditions; and approved by the Director, Office of Traffic and Safety.

#### **E. RUMBLE STRIPES**

Rumble stripes are to be milled or ground into the pavement surface with pavement marking material applied over top.

Installation of rumble stripes should be coordinated with permanent pavement marking and RPM placement. Permanent pavement markings and RPMs shall be installed after installation of the rumble strips is complete. Typically thermoplastic or paint materials shall be used for rumble stripe markings. Preformed tape materials shall not be used for rumble stripe application.

Rumble stripes should be installed as shown in Figures 6 & 7. Rumble stripes should be stopped 25 to 50 feet (25 feet for lower speed roadways and up to 50 feet for higher speed roadways) in advance of the point of curvature of intersections or at the beginning of the taper for the left-turn lane.

One of the key considerations for the installation of rumble stripes is maintaining a minimum effective lane width. Effective lane width is defined as the clear distance between a pavement marking or centerline rumble strip on the left side of the travel lane and the rumble strip associated with the rumble stripe on the right side of the travel lane. The minimum effective lane width that should be maintained is 9' - 4". This is calculated assuming a minimum travel lane width (measured from the roadway centerline to the pavement joint/edge) of 11' and subtracting 8" for half the width of centerline rumble strips, 6" for the minimum offset for rumble strips from the pavement joint/edge, and 6" for the rumble strip/stripe width.

Another consideration for the installation of rumble stripes is maintaining the existing shoulder width for bicycle use, regardless of whether the width meets 48" minimum required by current standards. The intent is not to remove the current usable bicycle area in order to install rumble stripes. For roadways with no shoulders consideration should be given to bicycle accommodations with rumble stripes. See Section III.A.3. for further guidance.

# **SPECIAL PROVISIONS**

CATEGORY 600  
SHOULDERS

SECTION 610 — SHOULDER RUMBLE STRIPS

**610.01 DESCRIPTION.** This work shall consist of grinding depressions into existing Hot Mix Asphalt and Portland Cement Concrete to form shoulder rumble strips at the locations specified in the Contract Documents or as directed by the Engineer.

**610.02 MATERIALS.** Not applicable.

**610.03 CONSTRUCTION.**

**General.** The rumble strip placement shall conform to the Contract Documents.

The rumble strips shall be ground into Hot Mix Asphalt (HMA) at a minimum rate of 4000 per hour, and into Portland Cement Concrete at a minimum rate of 1000 per hour.

**Equipment.** The equipment shall have rotary type cutting heads with a maximum outside diameter of 24 in. and a length of 16 in. The cutting heads shall have the cutting tips arranged in a pattern providing a relatively smooth cut (approximately 1/16 in. between peaks and valleys). The cutting heads shall be mounted on their own suspension, independent of the power unit, to allow the tool to self-align with the slope of the shoulder and any irregularities in the shoulder surface.

The cutting tool shall be equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity throughout the project. Alignment of the edge of the pattern will be randomly checked by the Engineer.

**Control Strip.** The Contractor shall grind a 100 ft minimum control strip to demonstrate to the Engineer that the speed of operation, dimensions, and texture are acceptable.

**Clean up.** The pavement shall be cleaned by sweeping or vacuuming the work area before the roadway is reopened to traffic. Waste material resulting from the operation shall be removed from the site, and disposed of in a manner approved by the Engineer. The material shall not be swept to the side of the road.

**610.04 MEASUREMENT AND PAYMENT.** Shoulder Rumble Strips in Hot Mix Asphalt and Portland Cement Concrete will be measured and paid for at the Contract unit price per linear foot as measured along the shoulder or center line of the roadway, within the limits of work. Payment will be full compensation for all installation of rumble strips, cleaning and disposal of waste material, control strips, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

**SPECIAL PROVISIONS**

**CONTRACT NO. XXX**

5xx – CENTERLINE RUMBLE STRIPS

1 of 1

CATEGORY 500  
PAVING

SECTION 5xx — CENTERLINE AND BETWEEN LANE RUMBLE STRIPS

**5xx.01 DESCRIPTION.** This work shall consist of grinding depressions into existing Hot Mix Asphalt and Portland Cement Concrete roadways to form centerline and/or between lane rumble strips at the locations specified in the Contract Documents or as directed by the Engineer.

**5xx.02 MATERIALS.** Not applicable.

**5xx.03 CONSTRUCTION.**

**General.** The rumble strip placement shall conform to the Contract Documents.

The centerline rumble strips shall be ground into Hot Mix Asphalt (HMA) at a minimum rate of 4000 per hour, and into Portland Cement Concrete at a minimum rate of 1000 per hour.

Pavement marking material shall conform to the applicable specifications in the Contract Documents for the material specified.

**Equipment.** The equipment shall have rotary type cutting heads with a maximum outside diameter of 24 in. and a length of 16 in. The cutting heads shall have the cutting tips arranged in a pattern providing a relatively smooth cut (approximately 1/16 in. between peaks and valleys). The cutting heads shall be mounted on their own suspension, independent of the power unit, to allow the tool to self-align with the slope of the roadway and any irregularities in the roadway surface.

The cutting tool shall be equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity throughout the project. Alignment of the edge of the pattern will be randomly checked by the Engineer.

**Control Strip.** The Contractor shall grind a 100 ft minimum control strip to demonstrate to the Engineer that the speed of operation, dimensions, and texture are acceptable.

**Clean up.** The pavement shall be cleaned by sweeping or vacuuming the work area before the roadway is reopened to traffic. Waste material resulting from the operation shall be removed from the site, and disposed of in a manner approved by the Engineer. The material shall not be swept to the side of the road.

**5xx.04 MEASUREMENT AND PAYMENT.** Centerline and Between Lane Rumble Strips in Hot Mix Asphalt and Portland Cement Concrete will be measured and paid for at the Contract unit price per linear foot as measured along the center line of the roadway, within the limits of work. Payment will be full compensation for all installation of rumble strips, cleaning and disposal of waste material, control strips, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Pavement marking materials and RPMs will be measured and paid for separately under the respective items as specified in the Contract Documents.

**SPECIAL PROVISIONS**

**CONTRACT NO. XXX**

5yy – APPLIED TRANSVERSE RUMBLE STRIPS

1 of 1

CATEGORY 500  
PAVING

**SECTION 5yy — APPLIED TRANSVERSE RUMBLE STRIPS**

**5yy.01 DESCRIPTION.** This work shall consist of furnishing and installing heat applied preformed thermoplastic pavement marking lines for use as transverse rumble strips as specified in the Contract Documents or as directed by the Engineer.

**5yy.02 MATERIALS.**

Preformed Thermoplastic is a durable pavement marking material. All Preformed Thermoplastic Pavement Marking material shall be selected from the Qualified Products List.

Heat Applied Permanent Preformed Thermoplastic Pavement Marking Material	951.06
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**5yy.03 CONSTRUCTION.** Refer to 556

**5yy.04 MEASUREMENT AND PAYMENT.** Applied Transverse Rumble Strips will be measured along the length installed multiplied by the number of layers, per each rumble strip within a set of rumble strips. Applied Transverse Rumble Strips will be paid for at the Contract unit price per linear foot for the color and width specified under the appropriate Preformed Thermoplastic Pavement Marking line items.

The payment will be full compensation for all pavement preparation, furnishing and placing of markings, testing, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

CATEGORY 500  
PAVING

SECTION 5zz —RUMBLE STRIPES

**5zz.01 DESCRIPTION.** This work shall consist of grinding depressions into existing Hot Mix Asphalt and Portland Cement Concrete roadways to form rumble strips for the application of edgeline pavement marking materials over top of the rumble strip. The finished product is referred to as rumble stripes at the locations specified in the Contract Documents or as directed by the Engineer.

**5zz.02 MATERIALS.** Not applicable.

**5zz.03 CONSTRUCTION.**

**General.** The rumble stripe placement shall conform to the Contract Documents.

The centerline rumble strips shall be ground into Hot Mix Asphalt (HMA) at a minimum rate of 4000 per hour, and into Portland Cement Concrete at a minimum rate of 1000 per hour.

The edgeline pavement marking material shall conform to the applicable specifications in the Contract Documents for the material specified.

**Equipment.** The equipment shall have rotary type cutting heads with a maximum outside diameter of 24 in. and a length of 16 in. The cutting heads shall have the cutting tips arranged in a pattern providing a relatively smooth cut (approximately 1/16 in. between peaks and valleys). The cutting heads shall be mounted on their own suspension, independent of the power unit, to allow the tool to self-align with the slope of the roadway and any irregularities in the roadway surface.

The cutting tool shall be equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity throughout the project. Alignment of the edge of the pattern will be randomly checked by the Engineer.

**Control Strip.** The Contractor shall grind a 100 ft minimum control strip to demonstrate to the Engineer that the speed of operation, dimensions, and texture are acceptable.

**Clean up.** The pavement shall be cleaned by sweeping or vacuuming the work area before the roadway is reopened to traffic. Waste material resulting from the operation shall be removed from the site, and disposed of in a manner approved by the Engineer. The material shall not be swept to the side of the road.

**5zz.04 MEASUREMENT AND PAYMENT.** Rumble Stripes in Hot Mix Asphalt and Portland Cement Concrete will be measured and paid for at the Contract unit price per linear foot as measured along the shoulder or center line of the roadway, within the limits of work. Payment will be full compensation for all installation of rumble strips, cleaning and disposal of waste material, control strips, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

Pavement marking materials will be measured and paid for separately under the respective item as specified in the Contract Documents.