



MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 14-07-T-01
May 21, 2014

To: Electronic Distribution Recipients
From: Susan M. Mulvihill, P.E. *SMM*
Deputy Commissioner / Chief Engineer
Subject: Rumble Strips and Stripes on Rural Trunk Highways

Expiration

This Technical Memorandum supersedes No. 11-02-T-02 (Rumble Strips and Stripes on Rural Trunk Highways) and shall remain in effect until May 21, 2017 unless superseded prior to this date or incorporated into the MnDOT Standard Plans, the Road Design Manual, and/or Traffic Engineering Manual.

Implementation

This policy shall be in effect for all programmed rural highway projects where the paved surface is constructed, reconstructed, or overlaid. This does not include preventive maintenance projects such as chip seals and microsurfacing; however, preventive maintenance projects on surfaces that have existing rumble strips or stripes shall ensure that these are perpetuated in accordance with the standards within this Technical Memorandum, particularly with respect to depth. Any paving constructed by MnDOT forces is exempt from the requirements of this Technical Memorandum.

This policy applies to all projects on Rural Trunk Highways where the posted speed limit is 55 mph or higher. For the purpose of this technical memorandum a Rural Trunk Highway is defined in the Definitions section. Districts may implement this policy on Urban Trunk Highways

While this policy provides for standards that will require an increased use of rumble strips and stripes, it also provides for more flexibility and discretion on the part of the District. Notably, the District has the discretion for the preferred lateral placement and width of the shoulder rumble strip in order to abate noise concerns, accommodate bicyclists, acknowledge pedestrian use, and manage pavement conditions.

The guidelines contained in this Technical Memorandum apply to all Rural Trunk Highways. However, other road authorities are encouraged to evaluate their needs accordingly.

Introduction

Detailed crash analysis has shown that lane departure crashes, such as run off the road, sideswipe and head-on crashes, on rural two-lane two-way highways in Minnesota result in an over represented number of fatalities and serious injuries.

Both traditional pavement markings and rumble strips are used to decrease the number of lane departure crashes. Following the lead of other states, MnDOT experimented with combining traditional pavement markings and rumble strips into a "rumble stripe," where the pavement marking is installed on the rumble strip.

The NCHRP Report 641 shows that the use of rumble strips both on the shoulder and beneath the centerline result in a significant reduction of targeted crashes. This report can be found at the following URL: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_641.pdf.

Additionally, numerous states in the region have enacted systematic policies to require rumble strips and rumble stripes on their trunkline roadways. Michigan, Missouri, and North Dakota have policies requiring centerline rumble stripes, plus edgeline rumble stripes or shoulder rumble strips, on most of their rural trunkline roadways

Studies have shown that the ambient noise decibel level generated by a vehicle driving over a properly constructed rumble strip is comparable to that of a truck passing by on a standard, non-rumbled surface. The noise from rumble strips may be more noticeable as the public is more accustomed to truck traffic, the frequency of the sound is different, and rumble hits tend to be more of an impulse noise. Due to these noise concerns, the District Traffic Engineer, based on engineering judgment, may gap centerline rumble stripe locations near residential homes.

Purpose

To provide centerline rumble stripes and/or shoulder rumble strips on all Rural Trunk Highways to reduce lane departure crashes, to provide increased centerline visibility during rainy conditions, and to guide motorists during weather conditions when striping visibility is poor.

Definitions

Shoulder Rumble Strips

These are defined as rumble strips outside of the edgeline.

Rumble Stripes

Rumble stripes are defined as a rumble strip that contains a pavement marking stripe. These will be referred to as either **edgeline rumble stripes** or **centerline rumble stripes**.

Rural Trunk Highway

This is defined as a roadway segment that has minimal residential or commercial development, with little or no further development anticipated in the future. Officially, rural segments will be defined by language in Chapter 2 of the MnDOT Access Management Manual. (Refer to the attached Reference 1, which shows the rural definition on page 10 in Chapter 2 of the MnDOT Access Management Manual.)

Requirements

Shoulder Rumble Strips

Shoulder rumble strips shall be placed on all rural highway construction and maintenance projects where shoulders are constructed, reconstructed, or overlaid and where the posted speed limit is 55 mph or greater, and the paved shoulder width is 4 feet or greater. Shoulder rumble strips may also be placed on rural trunk highways on shoulders less than 4 feet in width.

The location of the shoulder rumble strip will depend upon the width of the shoulder – see Figure 1 (Two-Way Bituminous Roadway with Paved Shoulder – Section View), Figure 2 (Two-Way Concrete Roadway with Paved Shoulder – Section View) and Figure 3 (Shoulder Rumble Strip on Divided Roadways) for typical dimensions. The District has the discretion for the lateral placement of the shoulder rumble strip in order to abate noise concerns and to accommodate bicyclists.

Shoulder rumble strips shall also be placed on the left shoulder of multi-lane divided roads.

Centerline Rumble Stripes

Centerline rumble stripes shall be placed on all rural highway construction and maintenance projects where pavement is constructed, reconstructed, or overlaid and where the posted speed limit is 55 mph or greater. This applies to both multi-lane undivided and two-lane undivided highways.

Exceptions

Based on engineering judgment, the District Traffic Engineer may gap centerline rumble stripes near residential homes, particularly in passing zone areas and curvilinear alignments. Appropriate gaps for driveway entrances can be found on Figure 10. If the gapping causes centerline rumble installation to be less than 1/8 mile (660 feet), the centerline rumble may be omitted for this segment.

Based on engineering judgment, the District Traffic Engineer may gap shoulder rumbles on the inside of a horizontal curve with nearby residences if a Safety Edge or wider shoulder is installed.

On rural highways where the lane width is 11 feet or less, or the paved shoulder width is 2 feet or less, shoulder rumble strips or edgeline rumble strips may be placed on both sides of the road in lieu of a centerline rumble stripe.

In all cases, edgeline rumble strips may be substituted for shoulder rumble strips and still meet the standards within this Technical Memorandum.

Shoulder rumble strips are not required in areas where there is a bus shoulder. However, it is assumed that bus shoulders will usually be installed in areas that are NOT defined as rural trunk highways in the Access Management Guide.

Shoulder rumble strips are not required in locations with guardrail or cable barrier implemented.

Even in cases where shoulder rumble strips are not required due to a narrow paved shoulder width, their installation, or the installation of an edgeline rumble stripe, is encouraged for proactive safety reasons.

Districts shall consider placing centerline rumble stripes and shoulder rumble strips on in-place shoulders at locations on which no construction, reconstruction, or overlay projects are scheduled in the near future as a systematic proactive safety measure. The District Materials Engineer should make recommendations regarding the structural adequacy of the in-place roadway and/or shoulder to receive rumble strips.

Width of rumble strips

Rumble strips are usually 12" in width. The width of the rumble strip can be reduced to within the range of 8"-12" when paved roadway width is limited. A 16" rumble is required on freeway segments. Any design of rumble strips that are smaller than 8" in width, or that deviate from the rumble cycle of 12" called for in Figures 4-8 shall require approval by the State Traffic Engineer.

The standard width of centerline rumble stripes is 16" of total rumble. The 16" may be continuous or split into two 8" rumbles which straddle the centerline pavement joint (each rumble typically 2" away from the joint, creating a 4" gap between rumbles). Any design of centerline rumble stripes that are smaller than 16" of total rumble width or that deviate from the corrugation cycle detailed in Figures 6 through 8 shall require approval by the State Traffic Engineer.

All rumble strips shall meet any and all specifications for Milled Rumble Strips in the MnDOT Standard Specifications for Construction or Special Provisions. This includes a requirement that rumble strips be milled in bituminous pavement, and not rolled.

The placement of shoulder rumble strips and edgeline rumble stripes with respect to the traveled lane shown in Figures can be deviated from at the discretion of the District.

Modifications for concrete pavement

On concrete paved roadway surfaces, there are two options for how to install shoulder rumble strips. They include:

- Installing 3' long structural rumble strips on alternating panels, and also shoulder rumble strips on the adjacent paved bituminous shoulder. (Refer to Figures 3C, 3D, & 7.)
- Milling in either continuous or intermittent shoulder rumble strips outside the edgeline, but on the concrete surface. (Refer to Figures 3C, 3D and 8.)

The recommended practice for placing centerline rumble stripes on concrete pavement is to install two 8" rumbles on either side of the centerline joint, each 2" away from the joint.

Shoulder rumble strips on Figure 8 and the rumble strips beneath the centerline marking in Figures 7 and 8 may be hand formed in construction, so long as the final dimensions conform to the depth and pattern in the typical drawing of Section B-B in Figure 8, and the appropriate respective width called out in this Technical Memorandum.

Bicycle travel on shoulders

Shoulder widths that provide less than 4 feet of clear space with rumble strips are not considered adequate to accommodate bicyclists. Where practical and feasible, Districts are encouraged to provide a minimum of a 6 foot paved shoulder where shoulder rumble strips will be placed on trunk highways with existing or potentially significant bicycle travel.

In order to meet the needs of bicyclists, flexibility has been built in to this Tech Memo. As stated above and reflected in the attachments, rumble strips as narrow as 8" as well as edgeline rumble stripes may be used at the discretion of the District. Also, while the dimensions in Figures 1 through 4 indicate the typical lateral placement of the shoulder rumble strip, the District has the discretion to deviate from this configuration with input from the State Bicycle Coordinator. Quality control of the lateral placement of rumble strips on these sections must be ensured.

The longitudinal rumble strip pattern for shoulder rumble strips and edgeline rumble stripes on non-freeway segments is to include a 12' gap in each 60' cycle. Refer to Figures 4B and 5B. This remains a standard from the previous two Technical Memoranda that are being combined. Districts may increase the gap from 12' in downhill sections with the approval of the State Traffic Engineer.

Questions

Any questions regarding the technical provisions of this Technical Memorandum can be addressed to the following:

- **Ken Johnson**, State Work Zone and Pavement Marking Engineer, at **(651) 234-7386**

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at <http://techmemos.dot.state.mn.us/techmemo.aspx>.

To add, remove, or change your name on the Technical Memoranda mailing list, please visit the web page <http://techmemos.dot.state.mn.us/subscribe.aspx>

Attachments:

Reference 1
Figures 1-10

FIGURE 1 - TWO-WAY BITUMINOUS ROADWAY WITH PAVED SHOULDER - SECTION VIEW

FIGURE 1A
(BITUMINOUS PAVEMENT OPTION 1 - SHOULDER RUMBLE STRIPS)

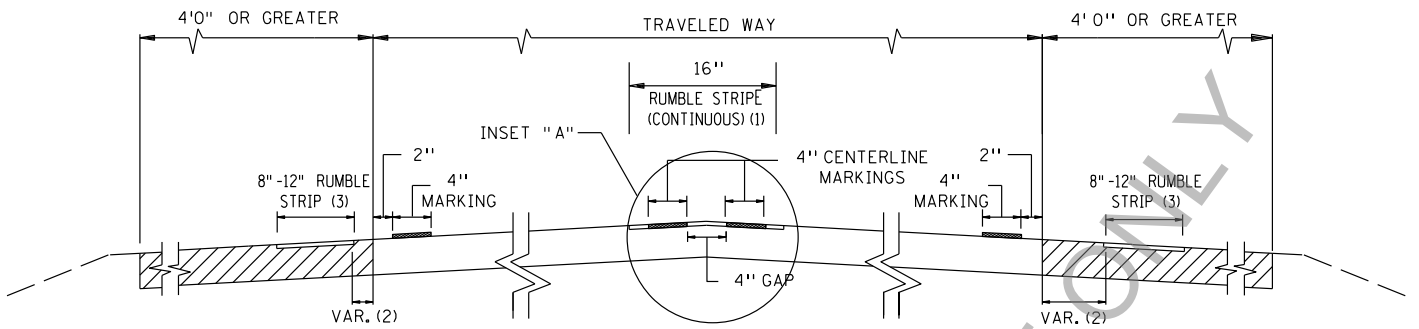


FIGURE 1B
(BITUMINOUS PAVEMENT OPTION 2 - EDGELINE RUMBLE STRIPS)

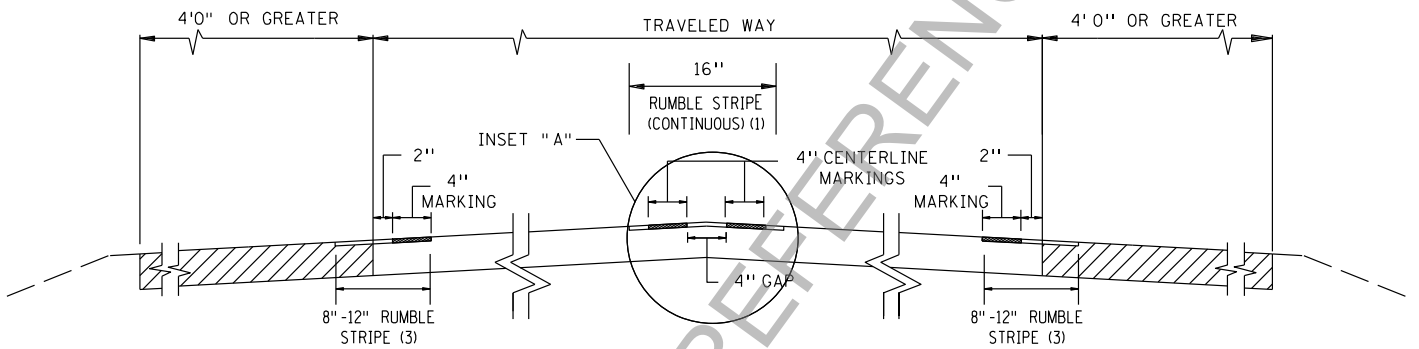
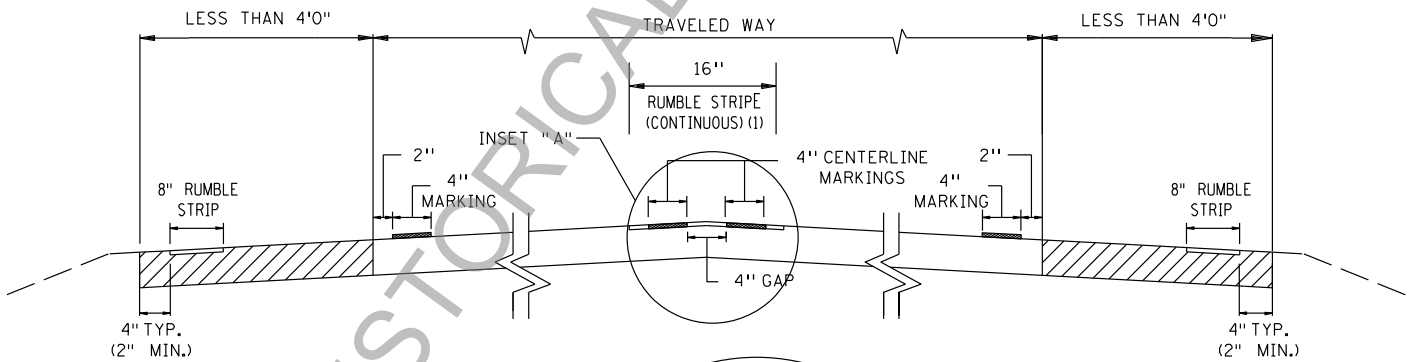
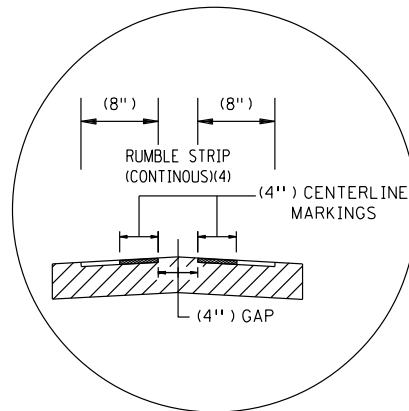


FIGURE 1C
(BITUMINOUS PAVEMENT WITH LESS THAN 4' PAVED SHOULDERS)



INSET "A"
OPTIONAL



- (1) SEE FIG. 6A FOR DETAILS.
- (2) 2" WHERE SHOULDER WIDTH IS LESS THAN 6'; 12" WHERE SHOULDER WIDTH IS 6' OR GREATER.
- (3) INTERMITTENT PATTERN, USE 8" RUMBLE STRIP/STRIPE WHERE SHOULDER WIDTH IS LESS THAN 6'.
- (4) SEE FIG. 6B FOR DETAILS.

FIGURE 2 - TWO-WAY CONCRETE ROADWAY WITH PAVED SHOULDER - SECTION VIEW

FIGURE 2A
(CONCRETE PAVEMENT OPTION 1 - STRUCTURAL EDGELINE AND SHOULDER RUMBLE STRIPS)

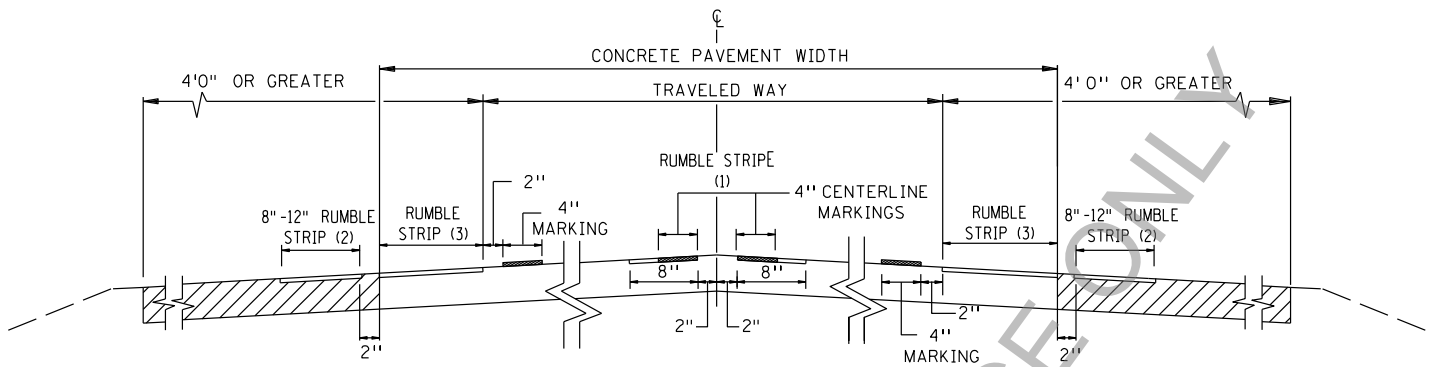


FIGURE 2B
(CONCRETE PAVEMENT OPTION 2 - EDGELINE RUMBLE STRIPS)

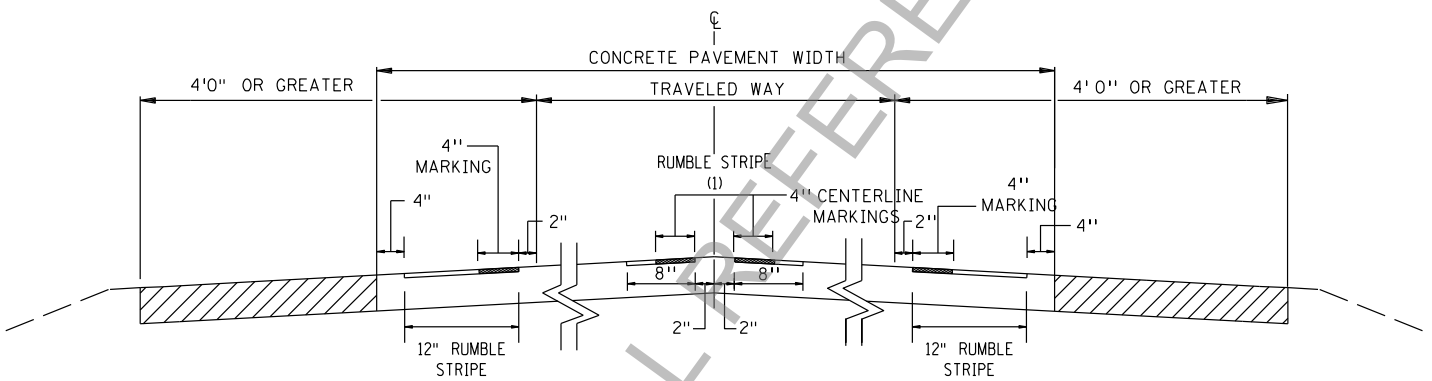
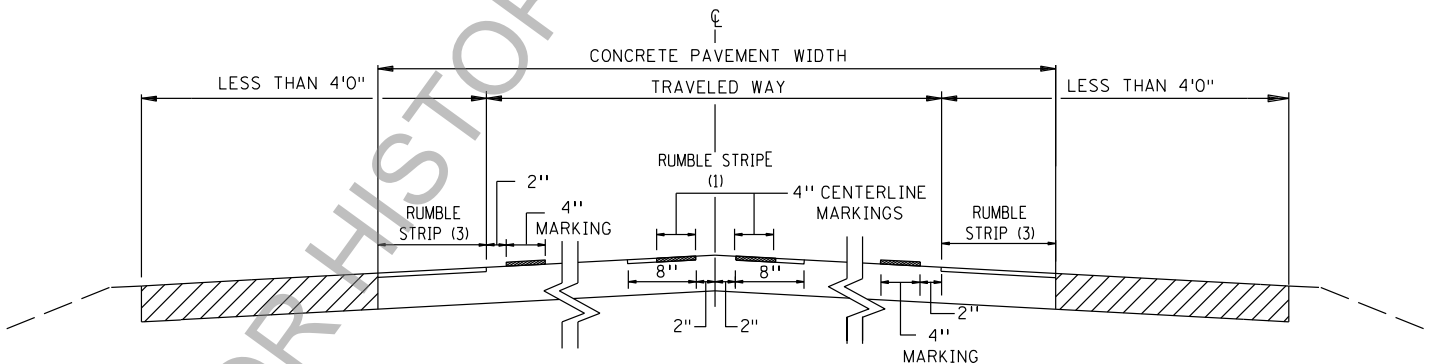


FIGURE 2C
(CONCRETE PAVEMENT WITH LESS THAN 4' PAVED SHOULDERS)



(1) SEE FIGS. 7 AND 8 FOR DETAILS.

(2) USE 8" INTERMITTENT WHERE SHOULDER WIDTH IS EQUAL TO OR GREATER THAN 6' AND LESS THAN 8'.
USE 12" INTERMITTENT WHERE SHOULDER WIDTH IS 8' OR GREATER.
NOT NECESSARY WHERE SHOULDER WIDTH IS LESS THAN 6'.

(3) WHERE SHOULDER WIDTH IS LESS THAN 6' USE GROUND-IN INTERMITTENT OPTION.
STRUCTURAL RUMBLES MAY BE USED IN ALL OTHER CASES.
SEE FIG. 7 AND 8 FOR RUMBLE STRIP OPTIONS, PLACEMENT, AND DIMENSIONS.

FIGURE 3 - SHOULDER RUMBLE STRIP ON DIVIDED ROADWAYS - SECTION VIEW

FIGURE 3A
BITUMINOUS FREEWAY (ONE ROADWAY SHOWN)

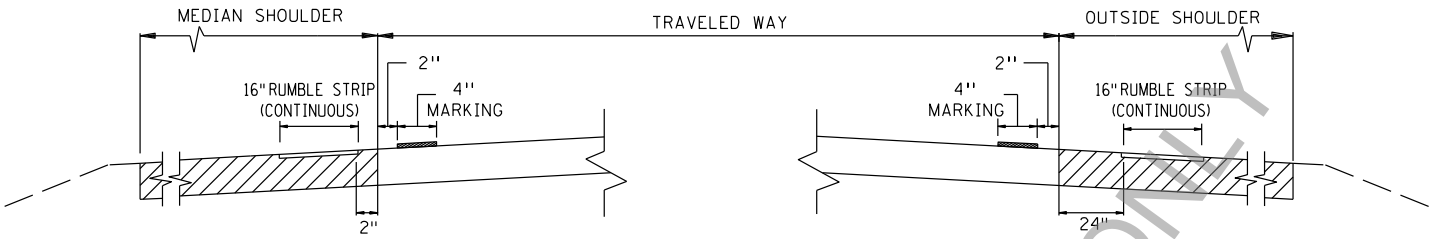


FIGURE 3B
BITUMINOUS MULTI-LANE (ONE ROADWAY SHOWN)

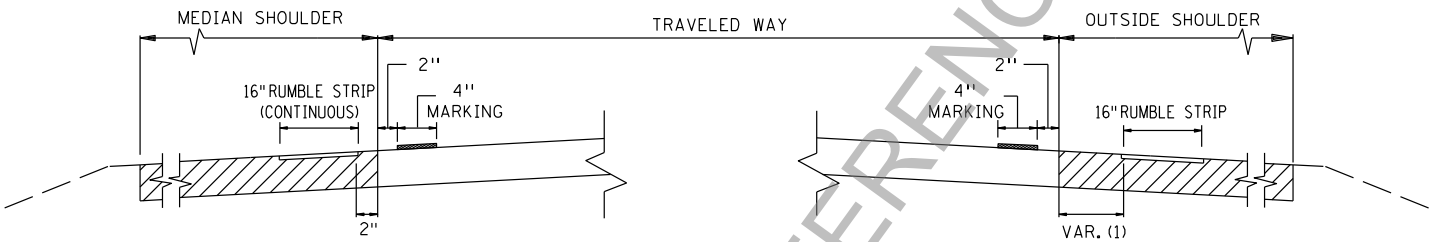


FIGURE 3C
CONCRETE FREEWAY/MULTI-LANE OPTION A (ONE ROADWAY SHOWN)

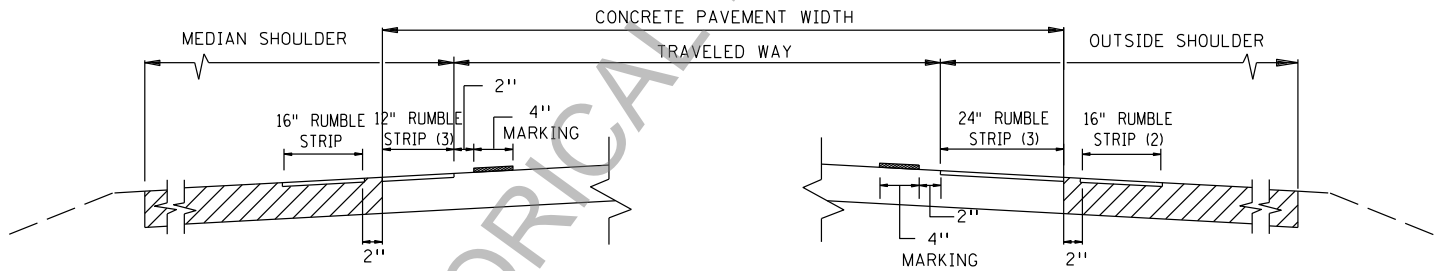
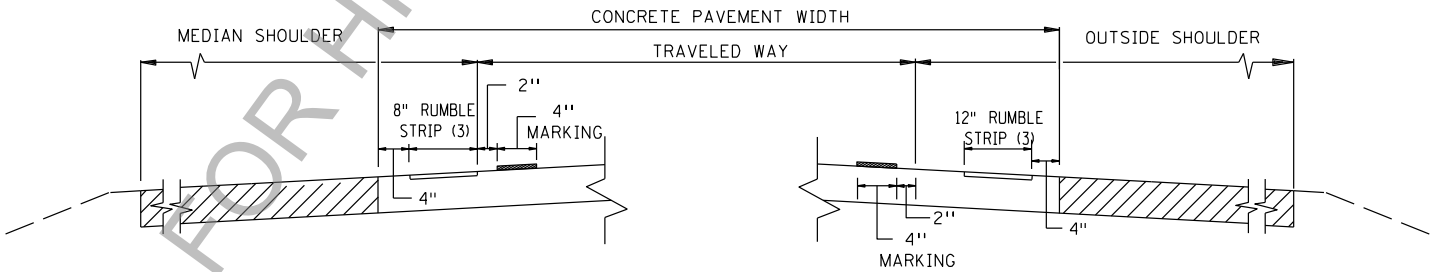


FIGURE 3D
CONCRETE FREEWAY/MULTI-LANE OPTION B (ONE ROADWAY SHOWN)



- (1) 2" WHERE SHOULDER WIDTH IS LESS THAN 6'; 12" WHERE SHOULDER WIDTH IS 6' OR GREATER.
- (2) USE 8" INTERMITTENT WHERE SHOULDER WIDTH IS EQUAL TO OR GREATER THAN 6' AND LESS THAN 8'.
USE 12" INTERMITTENT WHERE SHOULDER WIDTH IS 8' OR GREATER.
USE 16" CONTINUOUS ON FREEWAY.
NOT NECESSARY WHERE SHOULDER WIDTH IS LESS THAN 6'.
- (3) SEE FIG. 7 AND 8 FOR RUMBLE STRIP OPTIONS, PLACEMENT, AND DIMENSIONS.

FIGURE 4 - BITUMINOUS SHOULDER RUMBLE STRIP

FIGURE 4A - PLAN VIEW
CONTINUOUS

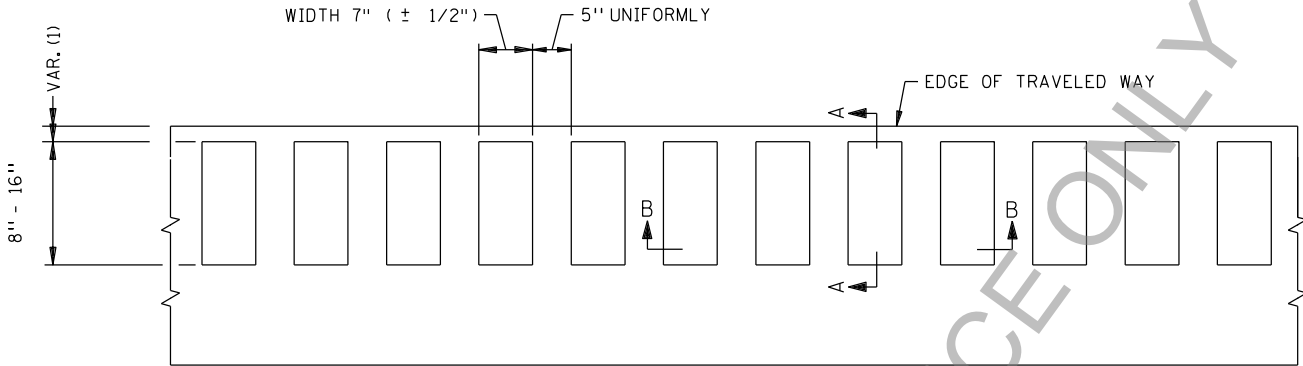
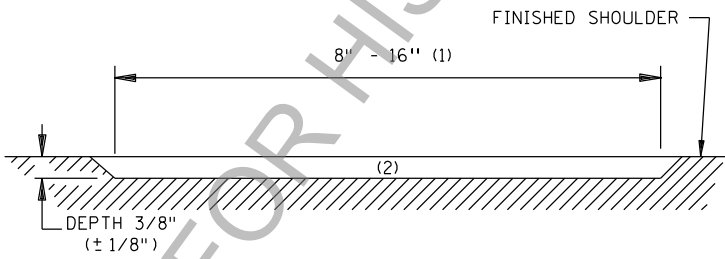
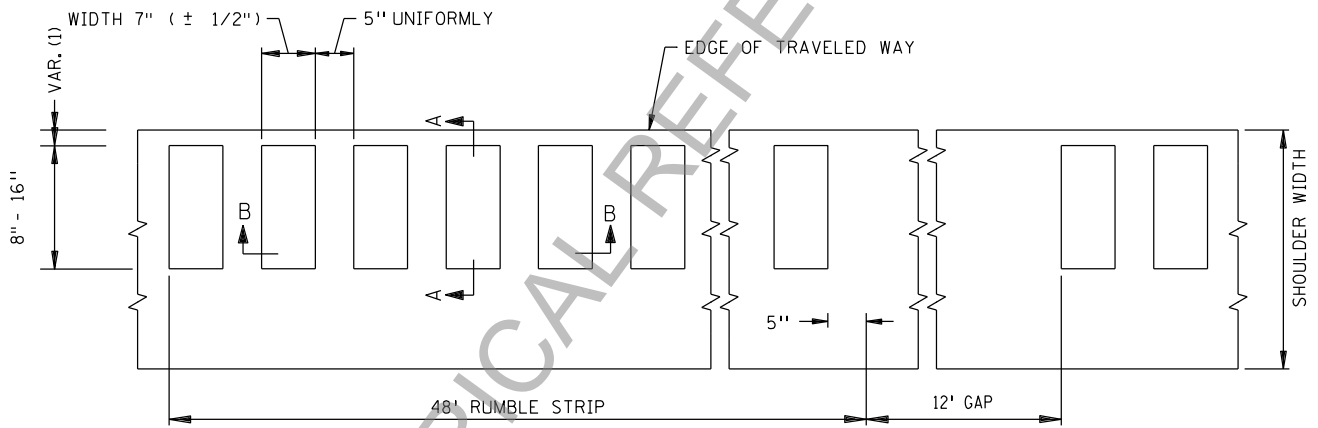
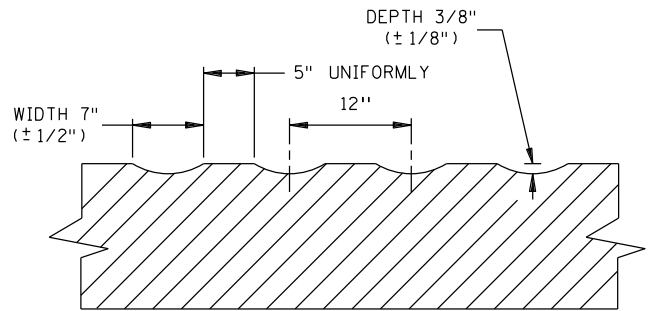


FIGURE 4B - PLAN VIEW
INTERMITTENT PATTERN



SECTION A-A



SECTION B-B

(1) REFER TO FIGURES 1 AND 3 FOR SPECIFIC APPLICATIONS.
(2) DEPTH OF RUMBLE SHALL BE UNIFORM.

FIGURE 5 - BITUMINOUS EDGELINE RUMBLE STRIPE

FIGURE 5A - PLAN VIEW
CONTINUOUS PATTERN

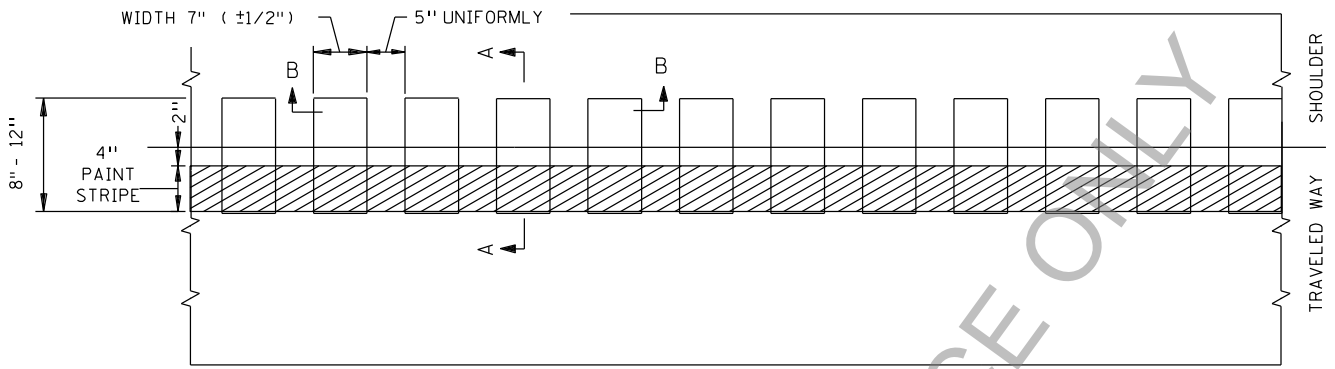
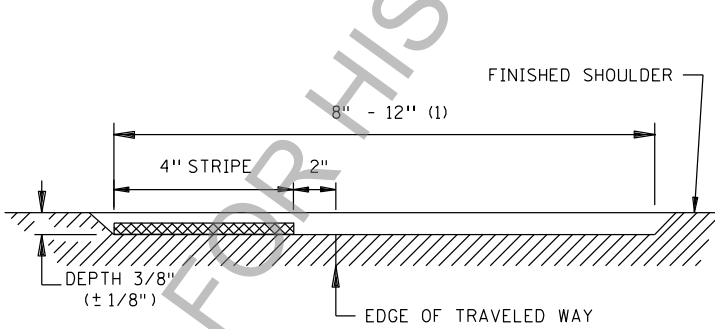
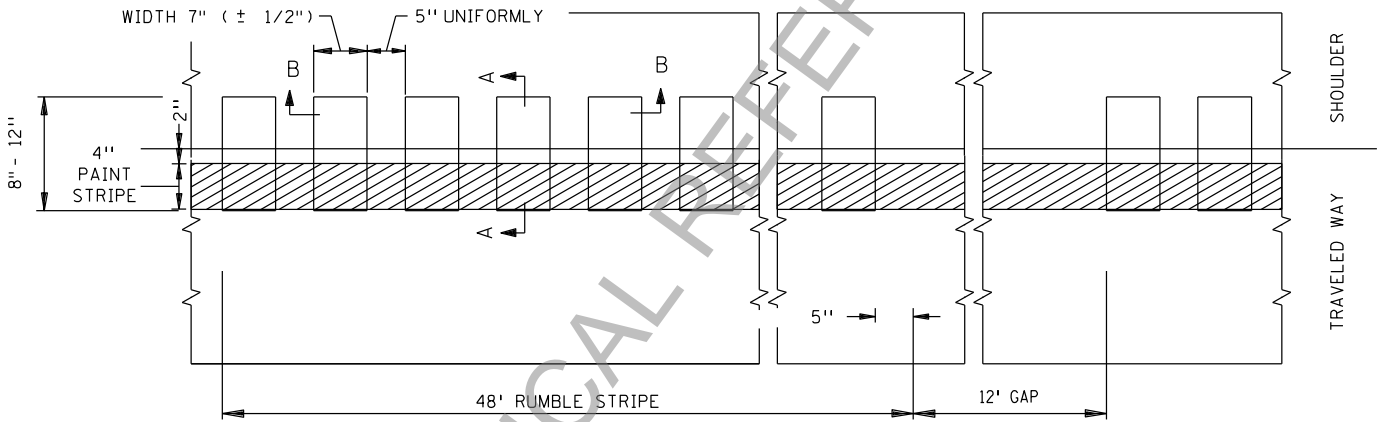
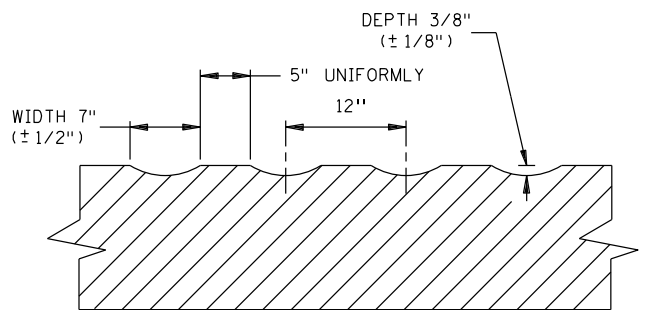


FIGURE 5B - PLAN VIEW
INTERMITTENT PATTERN



SECTION A-A



SECTION B-B

(1) USE 8" RUMBLE STRIPE WHERE SHOULDER WIDTH IS LESS THAN 6'.

BITUMINOUS CENTERLINE RUMBLE STRIPE - PLAN VIEW
 FIGURE 6A

16"

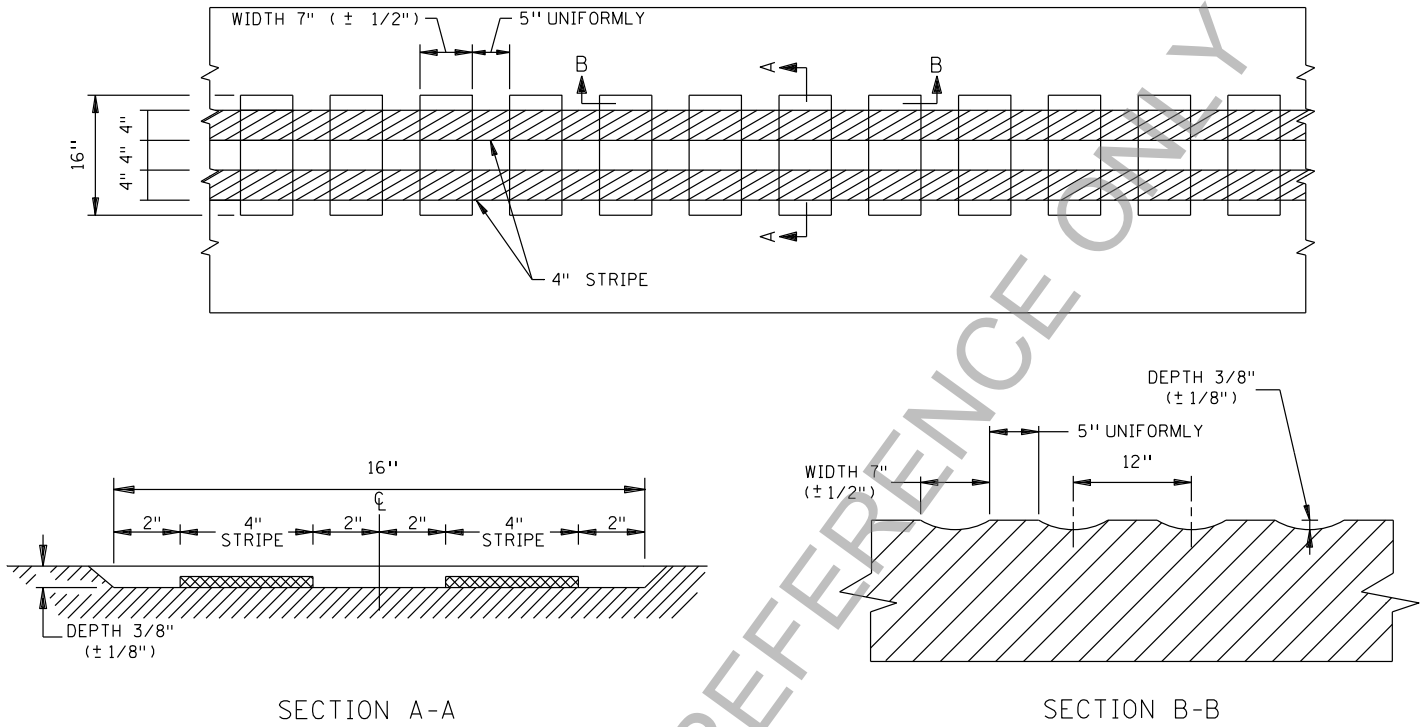


FIGURE 6 B

20"

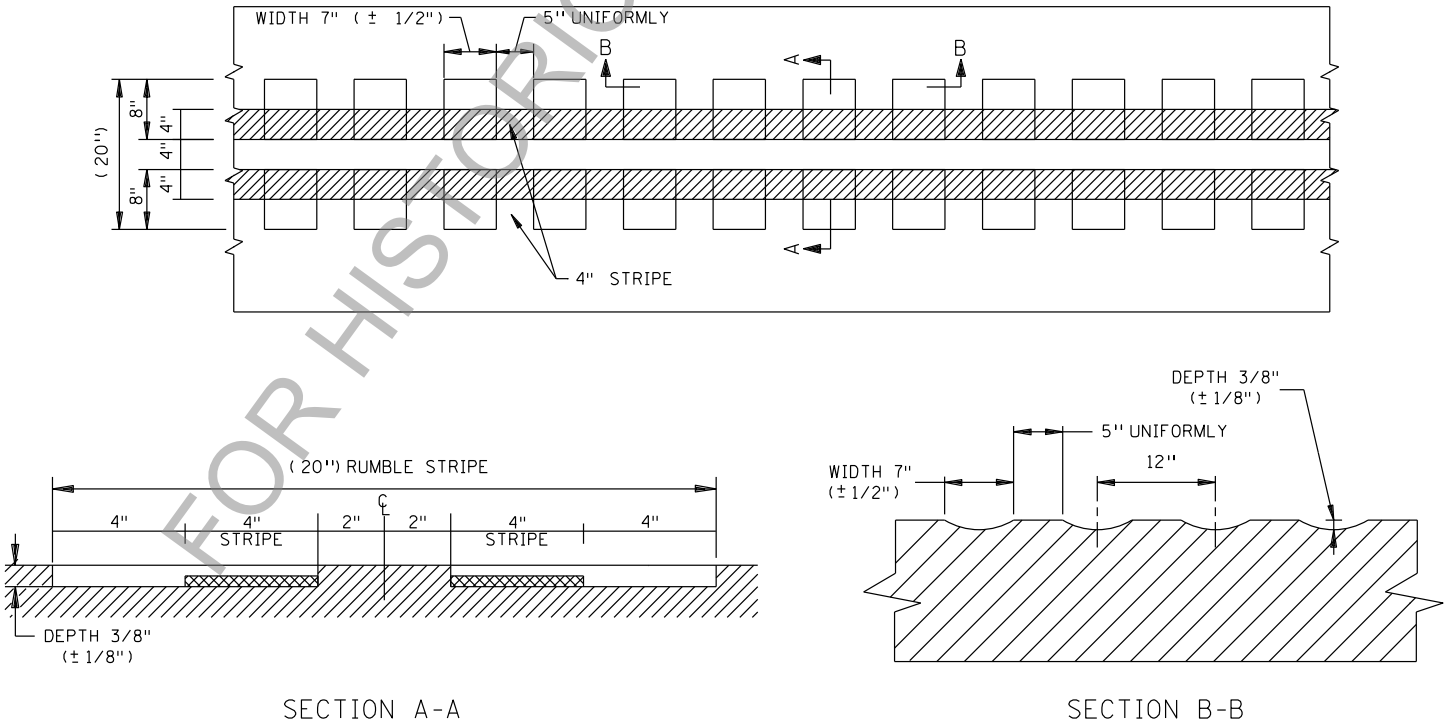
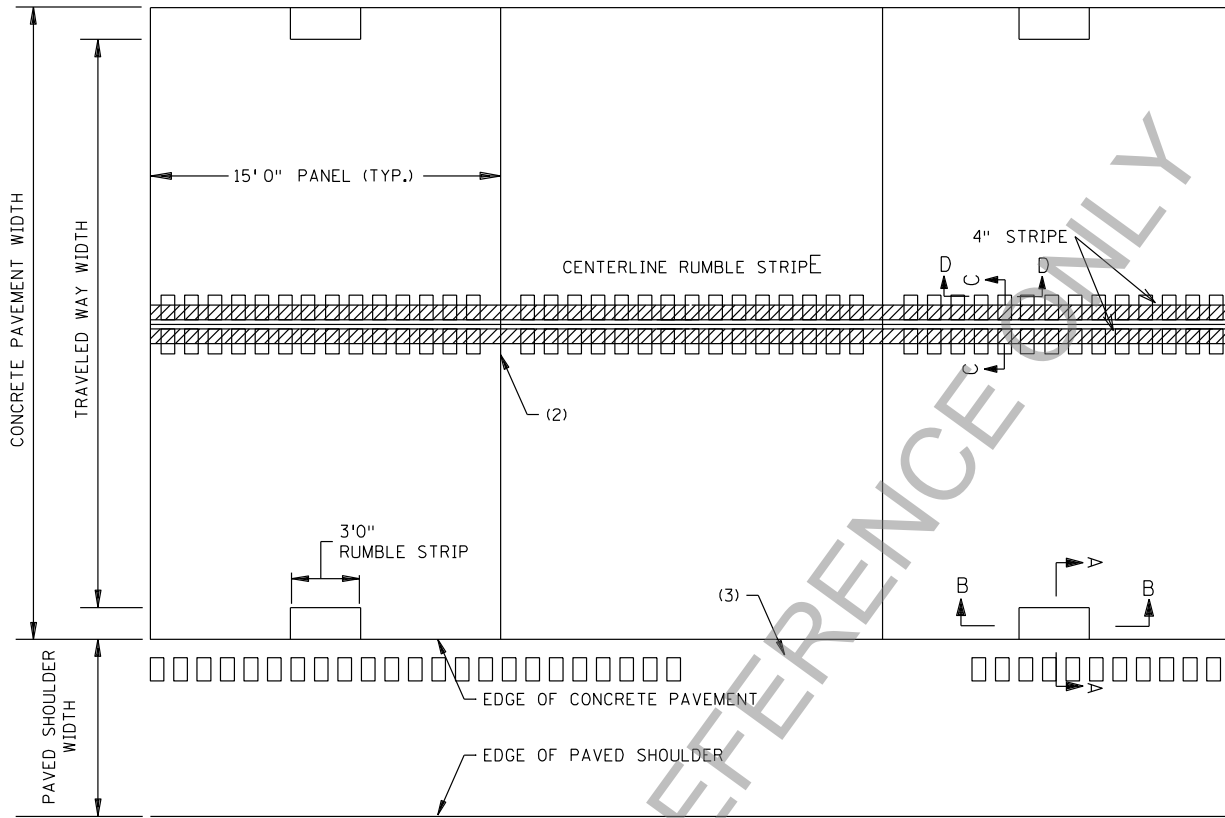
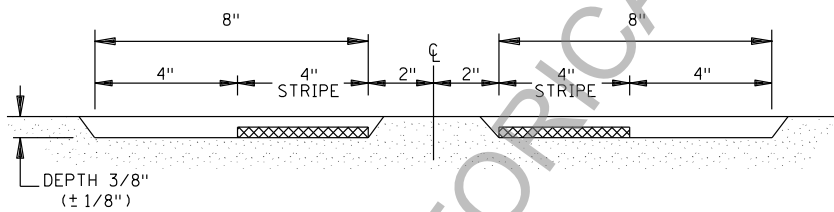


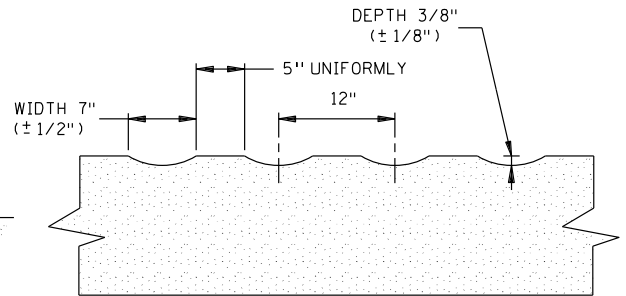
FIGURE 7 - CONCRETE PAVEMENT OPTION A - STRUCTURAL RUMBLE STRIP



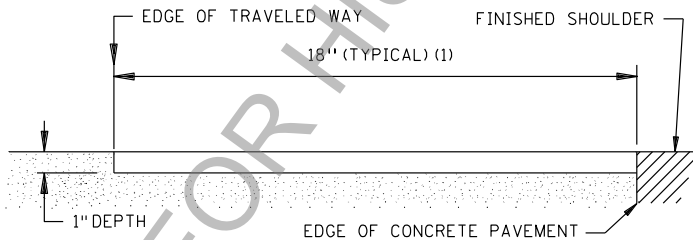
PLAN VIEW



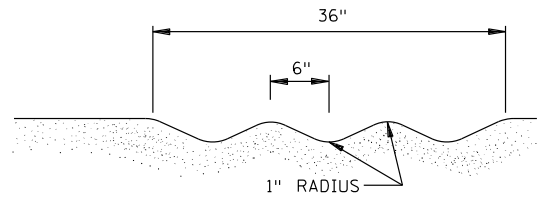
SECTION C-C



SECTION D-D



SECTION A-A



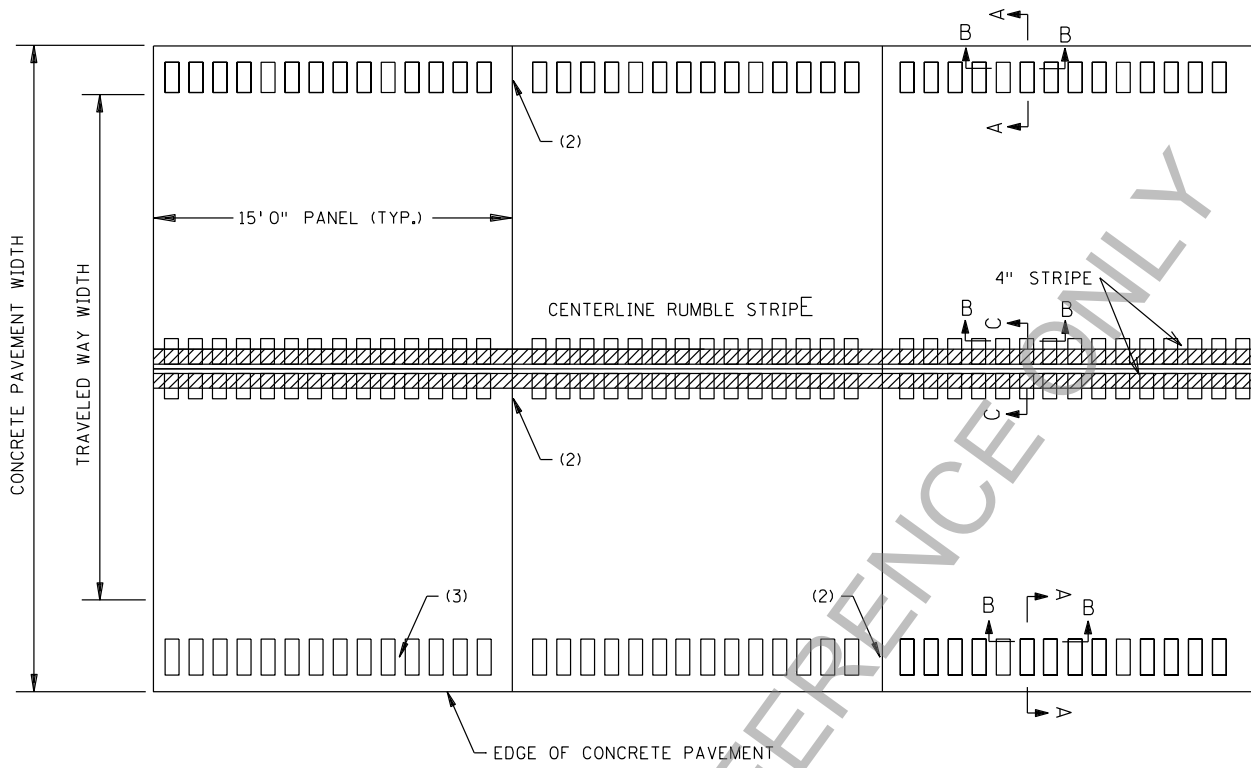
SECTION B-B

(1) FOR DIVIDED ROADWAYS USE 1'0" ON INSIDE LANE AND 2'0" ON OUTSIDE LANE.

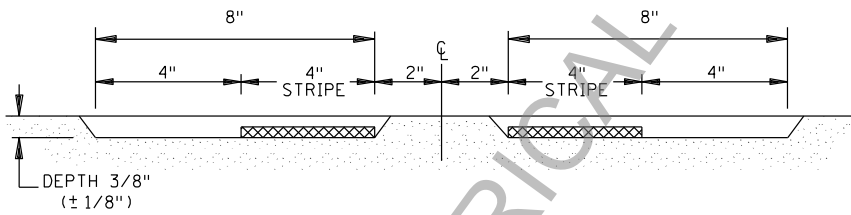
(2) OMIT ONE CORRUGATION SO THAT THERE IS AT LEAST 6" CLEARANCE ON EITHER SIDE OF TRANSVERSE JOINT.

(3) INTERMITTENT DESIGN SHOWN FOR ILLUSTRATION PURPOSES. REFER TO FIGURE 4B FOR INTERMITTENT PATTERN.

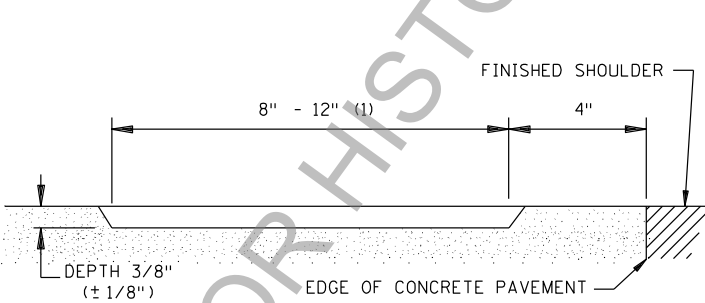
FIGURE 8 - CONCRETE PAVEMENT OPTION B - CONCRETE RUMBLE STRIPE



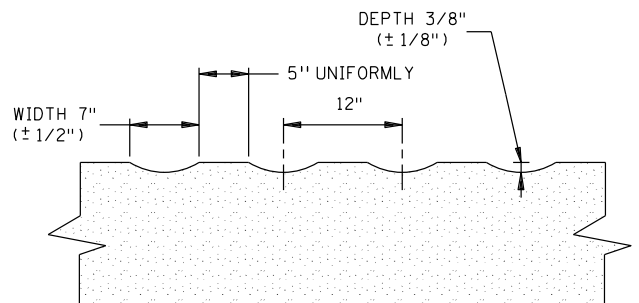
PLAN VIEW



SECTION C-C



SECTION A-A



SECTION B-B

(1) REFER TO FIGURES 2 AND 3 FOR SPECIFIC APPLICATIONS.

(2) OMIT ONE CORRUGATION SO THAT THERE IS AT LEAST 6" CLEARANCE ON EITHER SIDE OF TRANSVERSE JOINT.

(3) CONTINUOUS DESIGN SHOWN FOR ILLUSTRATION PURPOSES. REFER TO FIGURE 4B FOR INTERMITTENT PATTERN.

FIGURE 9 - SHOULDER RUMBLE STRIP - APPROPRIATE BREAKS

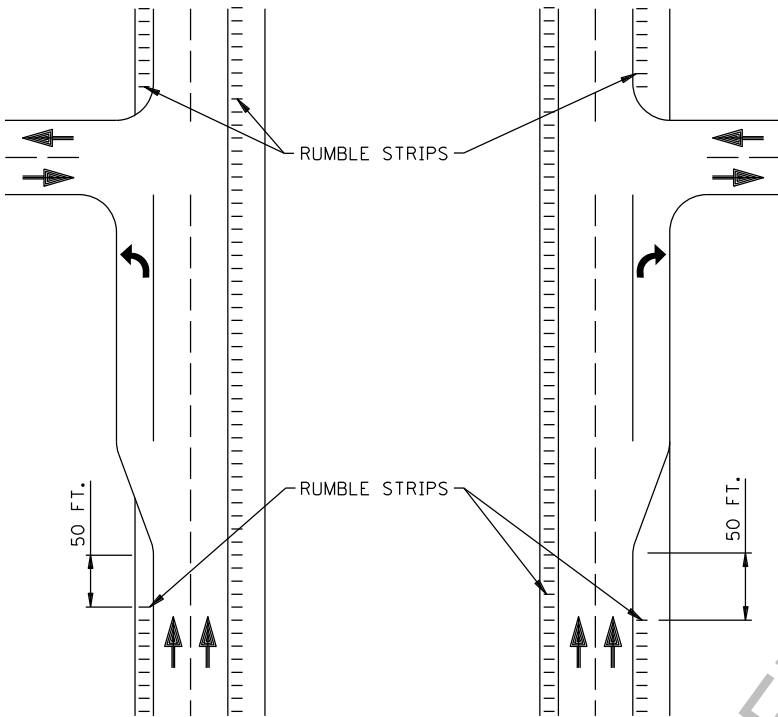


FIGURE 9A
LEFT TURN LANE

FIGURE 9B
RIGHT TURN LANE

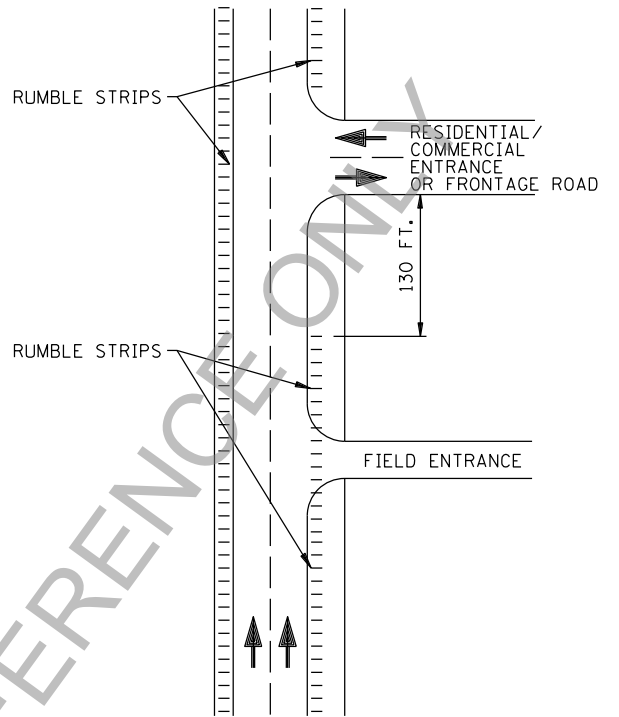


FIGURE 9C
ENTRANCE ROADS

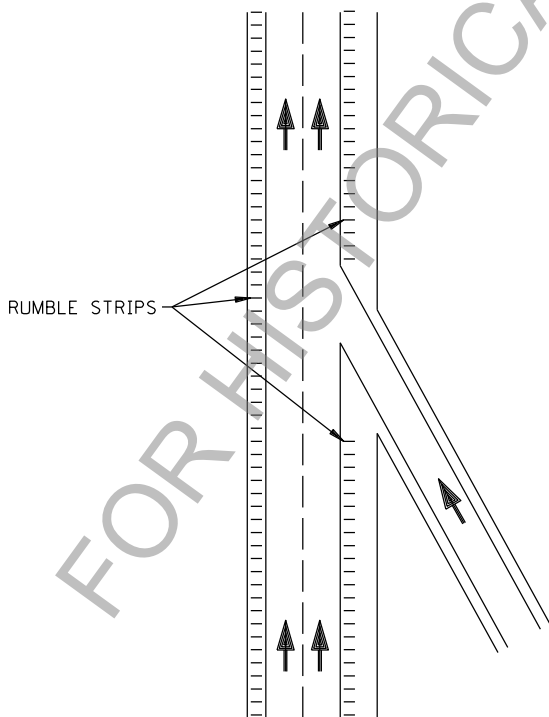


FIGURE 9D
ACCELERATION LANE

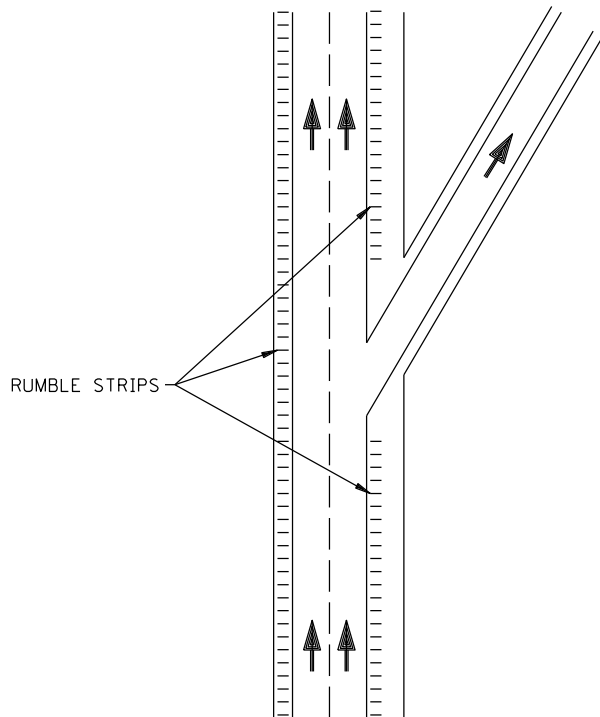
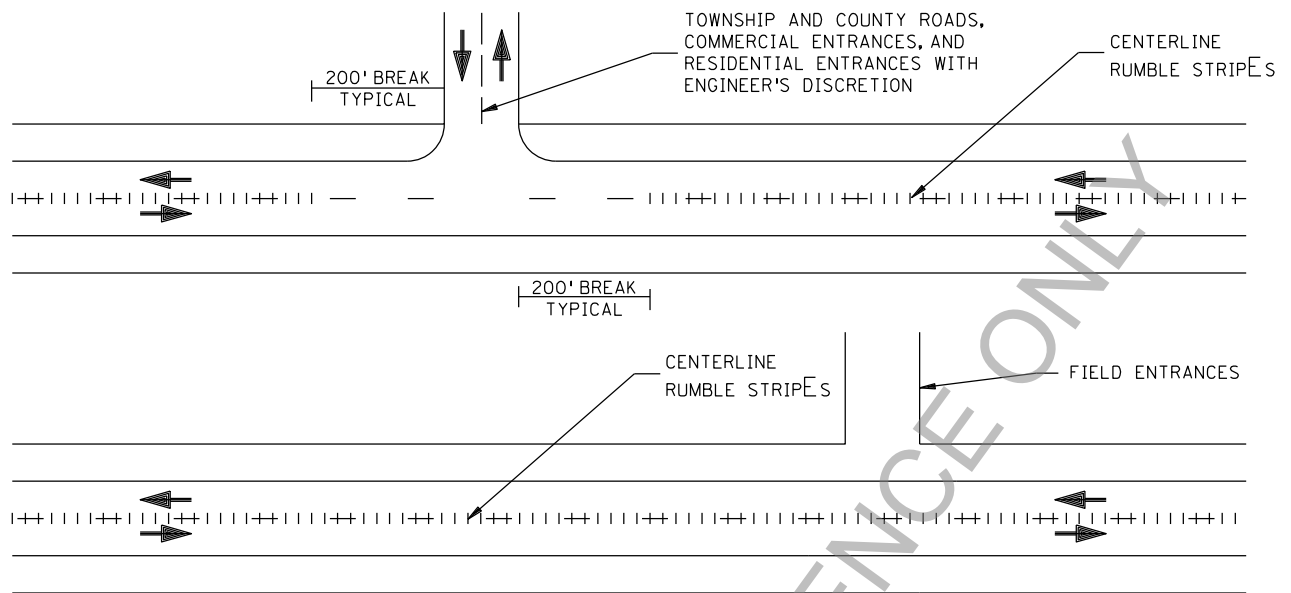


FIGURE 9E
DECELERATION LANE

FIGURE 10 - CENTERLINE RUMBLE STRIPE - APPROPRIATE BREAKS (1)



(1) PAVEMENT MARKINGS AND STRIPING SHALL BE COMPLIANT WITH THE CURRENT TRAFFIC ENGINEERING MANUAL (TEM) AND THE CURRENT MINNESOTA MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES (MN/MUTCD)

FOR HISTORICAL REFERENCE ONLY