

# Memorandum

*Making Conservation  
a California Way of Life*

To: DISTRICT DIRECTORS  
DEPUTY DIRECTORS

Date: January 14, 2021

From: RACHEL CARPENTER *Rachel A. Carpenter*  
Chief Safety Officer

Subject: **TRAFFIC SAFETY BULLETIN 20-07: RUMBLE STRIP GUIDELINES**

This traffic safety bulletin announces issuance of the Rumble Strip Manual. This manual is intended to guide project development staff in the implementation of longitudinal rumble strips on State Highway Systems. The California Department of Transportation (Caltrans) is committed to the Safe System approach and using proven, fiscally responsible safety countermeasures such as Proven Safety Countermeasures stemming from the Federal Highway Administration (FHWA) Every Day Counts Program. A key focus of the Safe System approach is to reduce death and serious injuries through design that anticipates human mistakes, such as inattentive or drowsy driving.



**Why it works:** Rumble strips alert inattentive or drowsy drivers that their vehicle is drifting out of their lane onto the shoulder or into the opposing lane. This reduces fatal and severe injury roadway departure crashes, including cross centerline collisions.

**Crash Modification Factor:** FHWA studies have shown that rumble reduce run-off-the-road crashes by 30 to 40 percent when placed on the shoulder and cross-over crashes by 40 to 60 percent when placed on the centerline.

The attached guideline provides direction for the proactive use of rumble strips on the State Highway System. You can download an electronic version of the manual from: <<https://safetyprograms.onramp.dot.ca.gov>>.

If you have any questions or need additional information, please contact Atifa Ferouz, chief of the Markings and Temporary Traffic Control Branch, Office of Safety Systems and Devices, Division of Safety Programs, at <[atifa.ferouz@dot.ca.gov](mailto:atifa.ferouz@dot.ca.gov)> or (916) 662-2397.

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Attachments  
Rumble Strip Guidelines

c: Janice Benton, Chief, Division of Design  
District Deputies, Operations



# Guidelines for Installing Rumble Strips on California State Highways

## INTRODUCTION

The California Department of Transportation (Caltrans) is committed to the Safe System<sup>1</sup> approach and using proven, fiscally responsible (or low cost) safety countermeasures on our State highways. A key focus of the Safe System approach is to reduce death and serious injuries through design that anticipates human mistakes, such as inattentive or drowsy driving.

Rumble strips are a Proven Safety Countermeasure for Reducing Rural Roadway Departures in the Federal Highway Administration (FHWA) Every Day Counts Program<sup>2</sup> and alert inattentive or drowsy drivers that their vehicle is drifting out of their lane onto the shoulder or into the opposing lane. This reduces severe fatal and injury roadway departure crashes, including cross centerline collisions. Rumble strips are usually installed longitudinally along paved shoulders and in the center of the roadway between opposing directions of traffic. As a vehicle's tires pass over a rumble strip, the driver receives an auditory and mild tactile warning to correct their steering path.



Figure 1: Typical shoulder and centerline rumble strips where bicycles are permitted.

<sup>1</sup> Institute of Transportation Engineers, <https://www.ite.org/technical-resources/topics/safe-systems/>

<sup>2</sup> Federal Highway Administration, [https://www.fhwa.dot.gov/innovation/everydaycounts/edc\\_5/roadway\\_departures.cfm](https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/roadway_departures.cfm)  
Federal Highway Administration, [https://safety.fhwa.dot.gov/provencountermeasures/long\\_rumble\\_strip/](https://safety.fhwa.dot.gov/provencountermeasures/long_rumble_strip/)



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The Federal Highway Administration Crash Modification Factor (CMF) Clearinghouse website<sup>3</sup> shows that shoulder rumble strips reduce run-off-the-road crashes by 30 to 40 percent while centerline rumble strips reduce cross-over crashes by 40 to 60 percent. A combination of both shoulder and centerline rumble strips may reduce crashes even further.

Caltrans policy for using rumble strips to address run-off-the-road crashes was originally established in March of 1987.<sup>4</sup>

## RUMBLE STRIP

**APPLICATION:** A rumble strip is a series of milled indentations on the centerline or along paved shoulders to alert or warn drivers they are leaving their lane of travel. They are effective, fiscally responsible countermeasure for preventing roadway departure type crashes.



Figure 2: Detail of standard rumble strip

**WHERE TO USE:** Except for locations detailed in "Breaks in Rumble Strip", page 6, projects on the State Highway System shall install rumble strips when any of the following conditions are met:



Figure 3: Standard shoulder rumble strip

1. on all freeway and expressway shoulders<sup>5</sup>.
2. on all rural facilities with a minimum clearance of four feet from the outside edge of the rumble strip to the outer edge of the paved shoulder with a posted speed greater than 35 mph<sup>6</sup>.
3. at locations identified by the annual Cross Over Collision Monitoring Program or Run off Road Collision Monitoring Program.

Engineering judgment should be used when considering installation on roads with speed limits of 35 mph or less. Locations where speed limits

<sup>3</sup> Federal Highway Administration Crash Modification Factor Clearinghouse, <http://www.cmfclearinghouse.org/>

<sup>4</sup> California Department of Transportation (Caltrans). Traffic Manual Section 6-03.22 – Manual Change Transmittal 3/25/87.

<sup>5</sup> Maryland. *Guidelines for Application of Rumble Strips and Rumble Stripes*. 08/07/2014.

North Carolina. Roadway Design Manual, Section 1-P. REV. DATE: 09/17/2004.

New Jersey. NJDOT Design Manual, Section 5.14. 2015.

<sup>6</sup>California Department of Transportation (Caltrans). Traffic Operations Policy Directive 11-04, October 5, 2011.



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are 35 mph or less typically have closer and more frequent noise receptors, frequent ingress/egress points, parking issues, and vehicles frequently entering and exiting the roadway. Patchwork placement of rumble strips in these locations would be ineffective and create a nuisance the public would likely object to. Additionally, research suggests the use of rumble strips is more effective at higher speeds<sup>7</sup>.

Each roadway with one or more sections of highway, that meets Collision Monitoring Program thresholds, need to be evaluated to determine if the rumble strip application should be expanded to the entire route or a major portion of the route for continuity. Criteria will include roadway features and traffic volumes.

Rumble strips shall be milled into the pavement in conformance with Standard Plans A40B through A40H. Pavement shall be in good or new condition to eliminate the potential of pavement raveling.

**WHO TO CONSULT:** The District Maintenance Engineer should be consulted regarding pavement quality to determine if the pavement condition is deteriorated or exhibits cracking.

## SHOULDER RUMBLE STRIP

**APPLICATION:** Shoulder rumble strips are intended to reduce single vehicle run-off-road crashes.

**WHERE TO USE:** The rumble strips are installed on highway shoulders, outside the travel lane. Shoulder rumble strips on divided highways should be installed on both the right (outside) and left (median) shoulders. Shoulder placement location can be found on Standard Plans A40B for standard milled rumble strips and A40G for sinusoidal rumble strips.

A minimum clearance of four feet from the outside edge of the rumble strip to the outer edge of the paved shoulder is required for rumble strips on the right shoulder. A minimum



Figure 4: Close-up of shoulder rumble strip

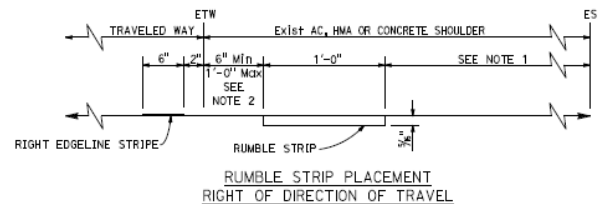
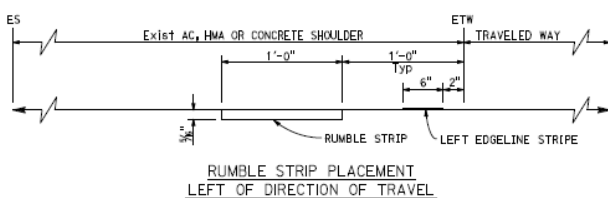


Figure 5: Typical Milled Rumble Strip Shoulder Placement

<sup>7</sup>Washington State Department of Transportation. Performance Analysis of Centerline Rumble Strips in Washington State: WA-RD 76.1, Table 5.10, March 2011.



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clearance of three feet is required for rumble strips on the left shoulder. Where bicycles are permitted, the minimum clearance of five feet is required for both shoulders.

**WHO TO CONSULT:** The District Traffic Safety Engineer shall be consulted when minimum widths can't be met for placing rumble strips to determine if edge line rumble strips are to be installed.

## EDGE LINE RUMBLE STRIP (RUMBLE STRIPE)

**APPLICATION AND WHERE TO USE:** Rumble strips that are placed at the edge of the travel lane and under the striping in narrow shoulder areas. Typical installations are in locations where clearances can't be met with shoulder rumble strips.

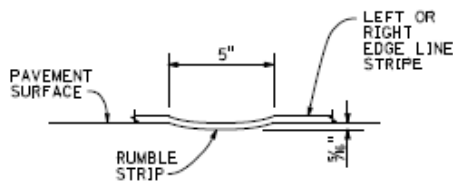


Figure 6: Typical detail of edge line rumble strip

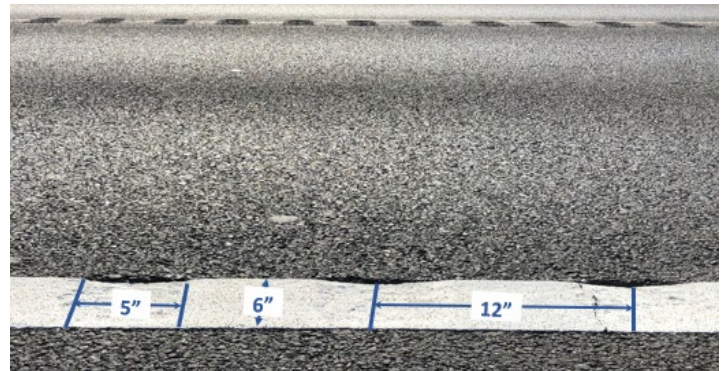


Figure 7: Photo of edge line rumble strip

The milled indentations are narrowed to 6 inches in width and the edge line pavement markings are placed over the top of the rumble strip (Standard Plan A40C).

**WHO TO CONSULT:** Approval by the District Traffic Safety Engineer is required when installing Edge Line Rumble Strips where bicyclists are permitted on the roadway.

## CENTERLINE RUMBLE STRIP (RUMBLE STRIPE)

**APPLICATION:** Centerline rumble strips are designed to reduce cross centerline crashes by warning drivers who are drifting across the centerline into an opposing travel lane.



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**WHERE TO USE:** The rumble strip is placed at or near the centerline of an undivided highway, and the pavement markings are applied over the rumble strip (Standard Plan A40D).



Figure 8: Photo of centerline rumble strip

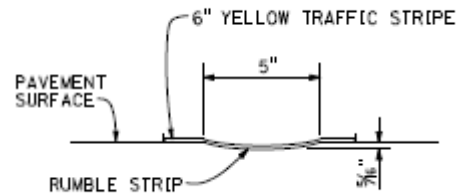


Figure 9: Typical detail of centerline rumble strip

Centerline rumble strips are to be placed between lanes where vehicles are traveling in the opposite direction. They are not to be used with two-way left turn lanes or striping that separates a turn lane from the through lane. Centerline rumble strips should be placed on all rural two-lane conventional highways with speeds greater than 35 mph. Placement of the centerline rumble strip include segments that permit passing.

## SINUSOIDAL RUMBLE STRIP:

**APPLICATION:** Sinusoidal Rumble Strips (Standard Plan A40G), or "Mumble Strips", reduce the exterior sound level while maintaining adequate tactile and audible warning inside the vehicle to alert the operator and occupants they are leaving the travel lane. The sinusoidal profile moves the higher frequency noise produced on a conventional rumble strip to lower frequencies by the repetition of the sine wave shape. External sound levels for sinusoidal rumble strips were reduced by more than six decibels<sup>8</sup> for passenger vehicles when compared to the standard rumble strip installation.

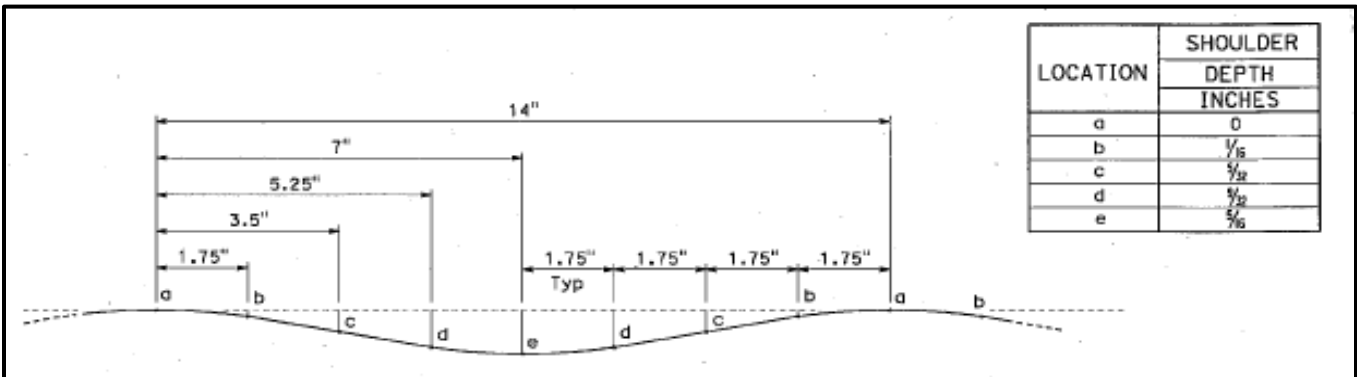


Figure 5: Cross section of sinusoidal rumble strip

<sup>8</sup> California Department of Transportation (Caltrans). *Design and Acoustical Evaluation of Optimal Sinusoidal Mumble Strips versus Conventional Ground-In Rumble Strips*. April 2018.



# Guidelines for Installing Rumble Strips on California State Highways

**WHERE TO USE:** Sinusoidal rumble strips should be considered when there are adjacent noise sensitive receptors (e.g., homes, schools, parks, wildlife habitat, etc.).

**WHO TO CONSULT:** Approval by the District Traffic Safety Engineer is required when installing sinusoidal rumble strips.

## BREAKS IN RUMBLE STRIP:

Rumble strips may be terminated prior to locations where, grinding will cause pavement deterioration, added noise from the rumble strip will adversely affect sensitive receptors (see Noise Considerations discussion below), or the clear width is below the distances on Standard Plan A40B. Specific features or areas where rumble strips are discontinued include:

- Intersections, driveways, and turn lanes (Standard Plan A40F)
- Entrance and exit ramps (Standard Plan A40E)
- Structures (i.e., bridges)
- Railroad Crossings (Standard Plan A40F)

## Bicycle Consideration



Figure 6: Photo of shoulder rumble strip gaps for bicycle to traverse rumble strip

Bicycling on the shoulder of a roadway requires an area of clear smooth pavement between the edge stripe and the edge of pavement or guardrail for the bicyclist to navigate freely. When obstacles are encountered, it is often necessary for the bicyclist to leave the shoulder by crossing over the edge stripe into the traffic lane then crossing back over the edge stripe back onto the shoulder area.

The Caltrans Traffic Manual<sup>9</sup> has identified the need for bicyclists to be able to safely traverse through or around rumble strips. The 1996 Traffic Manual<sup>10</sup> identified the requirement for a 1.5 meter (five feet) clear shoulder width for bicycle use between the rumble strip and the outside edge of shoulder. The bicycle community raised concerns regarding milled rumble strips ( $\frac{1}{2}$  inch to  $\frac{5}{8}$  inch in depth) in the mid to late 1990's. Caltrans finalized a study<sup>11</sup> in May 2001, to identify effective applications to alert drivers

<sup>9</sup> California Department of Transportation (Caltrans). Traffic Manual Section 6-03.2 – Manual Change Transmittal 10-1-81

<sup>10</sup> California Department of Transportation (Caltrans). Traffic Manual section 6-03.2. July, 1996.

<sup>11</sup> California Department of Transportation (Caltrans). *Evaluation of Milled-in Rumble Strips, Rolled-in Rumble Strips and Audible Edge Stripe*. May 2001.





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when they were leaving the roadway yet rideable for both bicycles and motorcycles. The study resulted in changes in the Caltrans Traffic Manual<sup>12</sup> which included standards for milled rumble strips.

As part of an effort to address the needs of bicyclists, Caltrans District 9 developed a pilot project to test intermittent gaps in the rumble strip patterns within the shoulder so bicyclists can safely move between the shoulder and travel lane as necessary (Standard Plan A40H). The gaps are designed such that it is unlikely a motor vehicle will cross the line of rumble strips without alerting the driver. The pilot project demonstrated that 12-foot gaps followed by rumble strips are both low cost and highly effective at enabling bicyclists to maneuver from one side of the rumble strips to the other. Caltrans Districts 3, 6, and 10 have also utilized the rumble strips with gap designs at several locations. As a result, Caltrans has developed standard plan details with 12-foot gaps followed by 48-foot rumble strips (a 60-foot cycle).

To better accommodate the needs of bicyclists, consideration may be given to providing intermittent gaps in the rumble strip patterns, compared to a continuous pattern (Standard Plan A40H). Provision of intermittent gaps enables bicyclists to maneuver from one side of the rumble strips to the other without having to encounter the milled indentations. This enables bicyclist to move into the travel lane to avoid debris, disabled or stopped vehicles, or when making left turns at an intersection or driveway.

**WHO TO CONSULT:** It is recommended that the District Traffic Safety Engineer evaluate the use of intermittent gaps when the following conditions are present:

1. There is adequate shoulder width to place shoulder rumble strips and
2. The highway is designated on a statewide or local bicycle route plan

Research by North Carolina State University<sup>13</sup> identified the need to extend the length of the gap on sustained grades where cyclists may reach sustained speeds of 30 mph or more. The comfort level for cyclists crossing the gap in rumble strip increases as sustained speeds rise. The rate of impacts with the rumble strip went down as the gap length increased. Vehicles departing the lane at three degrees would still impact the rumble strip if the gap length were increased to 18 feet. It is recommended that the gap in the rumble strip be increased to 18 feet when there is a sustained downgrade of three percent or more. District Traffic Safety Engineer approval is required to increase the length of the gap in the rumble strip.

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<sup>12</sup> California Department of Transportation (Caltrans). Traffic Manual section 6-03.2 – Manual Change Transmittal 9-13-02

<sup>13</sup> University of North Carolina. *Rumble Strip Gaps for High-Speed Bicycles*. January 2015.



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## NOISE CONSIDERATIONS

Rumble strips are normally located beyond the vehicle's normal wheel path and are not driven on continuously. Rumble strip strikes can be characterized as intermittent and brief impulses that don't elevate long term ambient roadway noise levels. Therefore, a project that installs rumble strips should typically not change or elevate the existing traffic noise levels. Overall, normal traffic noise on roadways with traffic volumes over 4000 AADT would likely dominate over temporary random or incidental noise contributed by the rumble strip. Placing rumble strips on highway segments where the speed limit is greater than 35 mph should eliminate most locations where added noise from the rumble strip could be a concern. Mitigation strategies to rumble strip noise impacts on isolated receptors adjacent to roadways include:

1. Avoid the placement of rumble strips in locations that have a high potential for repetitive strikes. Rumble strips should not be considered for highways with a speed limit of  $\leq 35$  mph, commercial/town centers, areas with high volume turning movements, or other location that generate high rates of ingress-egress movements on the shoulder.
2. Terminate rumble strips at a location 225 ft<sup>14</sup> from the receptor. This strategy must be approved by the District Traffic Safety Engineer.
3. Lower the noise level of the rumble strip by using sinusoidal rumble strip.
4. Place rumble strips beyond off-tracking vehicle wheel path around horizontal curves. Consider terminating the rumble strip if there is inadequate space to shift the alignment of the rumble strip.

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<sup>14</sup> Using the following equation  $L_2 = L_1 + 20 \log(D_1/D_2)$  where  $L_2$  is 12.6 dB (the extra noise from a vehicle striking the rumble strip),  $L_1$  is 81.5 Db for the average vehicle pass-by,  $D_1$  is 50 feet to the receptor, and solve for  $D_2$ . The distance ( $D_2$ ) is measured from the receptor and nearest ground-in indentation. This calculation is based on a single vehicle pass-by striking the rumble strip at 60 mph. Five percent was added to arrive at 225 feet.





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