USE OF TEMPORARY TRANSVERSE RUMBLE STRIPS IN WORK ZONES

A. INTRODUCTION

Temporary transverse rumble strips (also called in-lane or travel-way rumble strips) are grooved or raised corrugations that are placed on the highway pavement surface perpendicular to the path of travel, such that motor vehicles passing over the corrugations simultaneously generate audible and vibratory stimuli.

B. OBJECTIVE

- To alert motorists that they are about to enter a work zone where unusual or unexpected road conditions exist.
- To bring driver's attention to other warning devices.

C. LITERATURE REVIEW SUMMARY

C.1. ADVANTAGES

- The audible and vibratory stimuli produced by the rumble strips increases drivers' awareness and attention while traveling through work zones, particularly the inattentive, fatigued, or sleepy drivers.

C.2. DISADVANTAGES

- The noise generated by the rumble strips may cause complaints from nearby residents, particularly for deployments that are in place for an extended period of time.
- Rumble strips may provide an unexpected rough ride for motorcyclists and bicyclists.
- Due to wear, rumble strips gradually loss their effectiveness over time.
- Some drivers appear to have difficulties understanding the meaning and purpose of the rumble strips.

C.3. OTHER RELEVANT ISSUES

- The ability of the rumble strip to get driver's attention is directly related to the magnitude of the sound and vibration generated.
- The thickness and width of the rumble strip directly affects the amount of sound and vibration that each type of strip will produce. Thicker strips should increase the sound and vibration levels.
- The spacing between the individual strips and the sets of strips is critical in effectively obtaining the driver's attention.
- Rumble strips are particularly effective when placed on the road in advance of a flagger.
- Rumble strips are most effective when used in conjunction with other traffic control devices (e.g. lane shift signs, reduced speed limit signs, lanes divide sign, etc.).

D. DEPLOYMENT GUIDELINES

In addition to the guidelines described herein, implementation of the temporary transverse rumble strips should conform to the applicable guidelines in MUTCD section 6F.84

- A traffic engineering study should be conducted to ensure that rumble strip placement is necessary and will be effective.
- Temporary transverse rumble strips may be used in advance of detours, flaggers, lane splits, crossovers, lane transitions, exit only lanes, lane closures, temporary traffic signals, and locations with major reduction in speed limits.
- Temporary transverse rumble strips shall be placed prior to the work zone location.
- The closest set of rumble strips should be placed from 300 to 500 ft in advance of the work zone location.
- Temporary transverse rumble strips should be used with care at locations with high bicycle and motorcycle traffic volume; warning signs may be desirable.

- If high bicycle and motorcycle traffic volumes exist, then openings in the rumble strip patterns may be installed.
- Temporary transverse rumble strips should not normally be used in short-term maintenance work zones.
- Temporary transverse rumble strips should not be placed on sharp horizontal or vertical curves.
- The use of rumble strips near residential areas should be carefully evaluated.
- Temporary transverse rumble strips do not provide drivers any indication of what action may be desired. Hence, rumble strips should not be used alone, but in conjunction with other traffic control devices or visual cues that help drivers identify the appropriate action.
- To make cyclists, motorcyclists and motorists aware that the rumble strips are deliberate and to prevent erroneous drivers' responses, a "RUMBLE STRIPS AHEAD" warning sign should be placed in advance of zones where rumble strips are present.
- Temporary transverse rumble strips should extend onto the shoulder to discourage drivers from making erratic maneuvers to avoid the strips.
- Temporary transverse 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.

Disclaimer

The information provided in this section of the Maryland State Highway Administration's Work Zone Safety Tool Box is only to provide guidance. The Work Zone Safety Tool Box supplements current practices and standards provided in the current edition of the following documents:

1) The Manual on Uniform Traffic Control Devices (MUTCD)
2) The Maryland Supplement to the Manual on Uniform Traffic Control Devices
3) Maryland State Highway Administration Standard Sign Book
4) Maryland State Highway Administration Book of Standards for Highway and Incidental Structures
5) Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials

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F. CASE STUDY: TEMPORARY TRANSVERSE RUMBLE STRIPS EVALUATION

F.1. Introduction

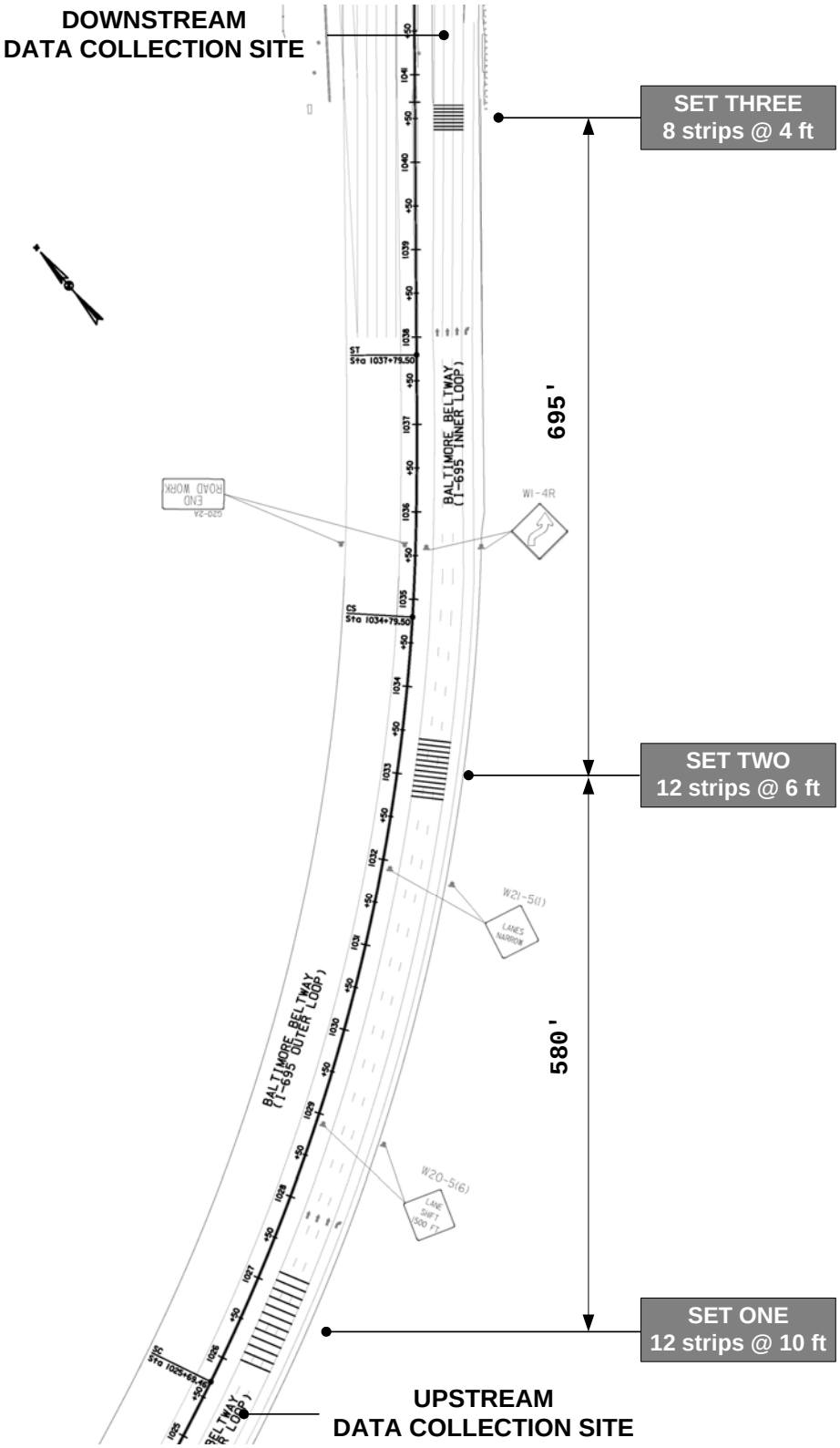
A study was performed for the Maryland State Highway Administration Office of Traffic & Safety to determine the effectiveness of implementing Temporary Transverse Rumble Strips prior to a work zone. Three (3) sets of rumble strips were placed prior to a work zone. Results showed the rumble strips were a minimally effective measure in reducing average speeds. However, greater driver alertness may have resulted through use of the rumble strips.

F.2. Location

The study was done on the Baltimore Beltway (I-695, Inner-Loop) between Greenspring Avenue and I-83 (JFX) southbound in Baltimore County, Maryland.

F.3. Typical Set-up

Three (3) sets of rumble strips were installed in advance of the work zone; set #1 being approximately 1,400 feet upstream of the work zone, set #2 being approximately 800 feet upstream of the work zone, and set #3 being approximately 100 feet upstream of the work zone. The rumble strip material cost approximately $4,600 and the installation of the strips cost $1,600. A figure showing the set-up for this deployment is displayed on the following page.


DOWNSTREAM
DATA COLLECTION SITE
SET THREE
8 strips @ 4 ft
695'
SET TWO
12 strips @ 6 ft
580'
SET ONE
12 strips @ 10 ft
UPSTREAM
DATA COLLECTION SITE
BALTIMORE BELTWAY
(I-695 INNER LOOP)
BALTIMORE BELTWAY
(I-695 OUTER LOOP)
ROAD WORK
END
W1-4R
W21-5(1)
LANES
NARROW
W20-5(6)
LANE
SHIFT
(500 FT)

F.4. Data Collection/Reduction Methodology

A speed spot study was performed where the studies were conducted. Most research studies make a great emphasis on analyzing data collected for free-flowing vehicles only, which are commonly defined as those vehicles with more than four seconds of headway. During the selected data collection periods, the Baltimore Beltway (I-695) carried heavy traffic volumes and thus, the application of the four-second rule was not feasible. Instead, to assure uniform and comparable test conditions, the data collected were differentiated in two categories: congested conditions and non-congested conditions. All data in the congested-condition category were removed from the database. Three measures of effectiveness were used for this test: (1) average vehicle speed, (2) 85^{th} percentile speeds, and (3) the speed distributions. Vehicles were systematically sampled by taking three readings per minute, one per each lane. The studies were conducted before implementation of the rumble strips, immediately after, one week, and three weeks after rumble strip implementation.

The study also investigated the roadside noise levels produced by the rumble strips. An analysis of the 1/3-octave band and overall sound levels was performed to evaluate the noise impact of the rumble strips. Three 24-hour sessions were conducted to collect data: (1) prior to the installation, (2) immediately after the installation, and (3) three weeks after the installation.

F.5. Results

The rumble strips' effect on vehicle speeds was inconclusive. The speed differentials between the upstream and downstream locations ranged from a decrease of 2.0 mph to an increase of 0.2 mph. As for the effect on the speed distributions, the rumble strips did not have an adverse effect and in all cases the distributions followed a Normal Curve shape.

The noise analysis showed that the noise produced by the rumble strips was audible within the frequency of normal hearing (approximately 3dB) but did not constitute a source of adverse noise impact or annoyance.

Some of the anticipated benefits of the audible and vibratory stimuli produced by rumble strips are increased drivers' awareness and attention while traversing the work zone (not

measured in this study), particularly of those inattentive, fatigued, or sleepy drivers. Consequently, it was recommended that in future rumble strips evaluations, an effort should be made to incorporate other performance measures to quantify the rumble strips' effect drivers' awareness and attention.

In conclusion, although in the present study rumble strips did not produce the desired speed reduction effect, its use for work zone applications is still highly encouraged; though, not as a speed control measure but as a driver's attention-catching device. Transverse rumble strips are mentioned in Section 6F.84 of the MUTCD 2003 Millennium Edition as a temporary traffic control device and are being currently used and tested by several other state transportation agencies.