KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Add a new SECTION to DIVISION 1700:

SECTION 1734

PORTABLE REUSABLE TEMPORARY RUMBLE STRIPS

1734.1 DESCRIPTION

This specification covers the required in-place performance characteristics of portable reusable temporary rumble strips.

1734.2 REQUIREMENTS

a. General. Rumble strips may be one-piece, or composed of individual panels or sections joined together to form an individual strip. Strips must rely on their weight and friction (no adhesive) with the pavement surface to stay in place during use.

b. Performance Testing.

(1) Determine Average Relative Longitudinal Movement (ARLM), Average Rotation (AROT), and Lateral Displacement after 40 passes of a test vehicle at speeds of 67.5 mph, 57.5 mph, 37.5 mph, and 22.5 mph.

(2) Determine the Average Peak Sound (APS) generated by test car traversing the rumble strips at speeds of 67.5 mph, 57.5 mph, 37.5 mph and 22.5 mph.

c. Performance Criteria.

(1) Provide rumble strips that satisfy the requirements for one or more device classes shown in **TABLE 1734-1**. Compare the absolute values of calculated ARLM and AROT, and the calculated value for APS to the maximum permitted values in the table. In addition, compare lateral movement during testing with the allowable.

TABLE 1734-1: IN-PLACE PERFORMANCE REQUIRMENTS

Device Class	Vehicle Traverse Speed (MPH)	Average Relative Longitudinal Movement* (± inch)	Lateral Movement	Average Rotational Movement** (± degrees)	Average Peak Sound*** (dB)
1	67.5	0.5 max.	Restricted to edges of 12' lane.	1.5 max.	89 min.
2	57.5	1.0 max.		2.5 max.	86 min.
3	37.5	1.0 max.		2.5 max.	79 min.
4	22.5	1.5 max.		5.0 max.	72 min.

* As measured at left edge, right edge and at the mid-length of the panel.
** Average value for three strips.
*** Using the test car only.

(2) During testing, individual strips composed of multiple pieces, sections, or components must stay intact.

(3) Devices must satisfy all the requirements of **subsections 1734.2c.(1) and (2)** for a particular class in order to be prequalified at that class. Class 1 devices have the highest performance rating and may be used anywhere. Class 2 devices may be used only where contract documents specify Class 2, 3 or 4 devices. A similar hierarchy applies to the Class 3 and 4 devices also.

1734.3 TEST METHODS

Performance test the product in accordance with the attached appendix (Kansas Test Method KT-85).

1734.4 PREQUALIFICATION

a. All portable rumble strips must be prequalified on the basis of device class prior to use. Manufacturers desiring to supply their product for KDOT projects must submit a written request to the Chief, Bureau of Transportation Safety & Technology, with the following information for each brand and product name:

(1) Name, address and contact information of the manufacturer and preferred representative.

(2) Brand name of the material.

(3) Highest Class attained through performance testing of the product using the test method contained within the attached appendix.

(4) Information regarding installation and maintenance, including suggested inspection intervals.

(5) One copy of a test report prepared by the agency, organization, or laboratory that performed the performance testing. Provide all information listed in Report Section of the appendix.

(6) A written certification (on company letterhead) from the testing entity stating that all testing was in conformance with this specification, including the attached appendix.

b. The required information and test reports will be reviewed by the Bureau of Transportation Safety & Technology. The manufacturer will be advised whether the product will be prequalified.

c. The Bureau of Construction & Materials will maintain a list of prequalified portable rumble strips. Products will remain prequalified provided the product's performance in the field is satisfactory and the product design and materials do not change. KDOT reserves the right to require retesting or to perform its own performance testing should a product's performance in the field not correspond to anticipated field performance suggested by prequalification testing. Poor field performance or updated testing data my result in a change in device class or a product's removal from prequalified status.

1734.5 BASIS OF ACCEPTANCE

Prequalification as described in **subsection 1734.4**.

Receipt and approval of a Type C Certification as specified in **DIVISION 2600**.

Visual inspection at the point of usage for condition and compliance with general requirements.

APPENDIX: PROCEDURES FOR EVALUATING THE MOVEMENT, ROTATION AND SOUND GENERATION OF PORTABLE TEMPORARY RUMBLE STRIPS (Kansas Test Method KT-85)

1. SCOPE

This method covers the procedures for evaluating the movement (longitudinal and lateral), rotation, and sound generation of portable temporary rumble strips. This appendix reflects testing procedures found in the KDOT sponsored research report KU-14-6.

2. REFERENCED DOCUMENTS

2.1. KU-14-6, August 2015, "Development of Temporary Rumble Strip Specifications"

3. DEFINITIONS

3.1. Downstream – the direction of test vehicle travel as it traverses the rumble strips.

3.2. Upstream – the direction opposite of test vehicle travel as it traverses the rumble strips.

3.3. Left/Right – as when looking in the downstream direction.

4. APPARATUS

4.1. Front wheel drive, full-size passenger car.

4.2. Tandem-axle dump truck with axle loads (front to rear) of 18 kips, 20 kips, and 20 kips.

4.3. Paved closed course having sufficient length to permit test truck (see **section 4.2**) to safely attain a constant speed of 67.5 mph and then safely decelerate after traversing the rumble strips.

4.4. A minimum of 120 feet of 4" wide white or yellow temporary pavement marking tape.

4.5. Sound level meter capable of measuring frequency-weighted sound pressure levels with output in decibels (dB). The meter must have a range of 20 to 140 dB and an accuracy of ±0.1 dB.

4.6. A 12 megapixel (MP), ƒ/1.8 digital camera.

4.7. A thermometer to determine ambient temperature at the test site.

5. SET-UP

5.1. Make certain the pavement in the test area is clean and dry, without the presence of dust, sand or gravel.

5.2. Place temporary pavement marking tape in two parallel straight lines 12 feet apart. The tape will delineate a minimum 60-foot long test lane.

5.3. Locate three individual rumble strips so that they are perpendicular to the edge lines, centered within the 12-foot test lane and spaced as per the manufacturer's recommendations. Do not use an adhesive to secure the strips to the pavement.

5.4. Mark the pavement at the four corners of each of the three undisturbed rumble strips so the rumble strips can be returned to their initial location after completing all passes at a test speed.

5.5. Position a sound meter 6 feet from a lane line, centered on and facing the middle rumble strip.

5.6. Movement and sound generation testing may proceed only when the ambient temperature is 55 to 75 degrees F.

5.7. Record all movement related measurements to the nearest tenth of an inch.

6. TEST PROCEDURE – MOVEMENT (TRUCK & PASSENGER CAR)

6.1. Using the test truck, traverse the rumble strips 40 times at 67.5 mph in the same direction. Proceed to **steps 6.2 through 6.6** only after completion of the 40th pass.

6.2. Photograph the displaced strips so that relative locations to one another and to the lane line are apparent for all three strips. Take close-up photos of strips that are damaged or if adjacent strip sections become detached.

6.3. Using the upstream or downstream side of each strip as a zero-reference line, measure and record the longitudinal displacement of the corresponding left corner, panel length midpoint, and right corner of each strip in inches. Each strip is treated separately. Therefore, a point on a displaced strip is measured along a line parallel to a lane line from the displaced point back to the "zero" reference line for the same strip. All measurements are taken parallel to a lane line. Downstream movements from the reference line are positive (+), upstream movements are negative (-).

6.4. Measure and record the final longitudinal clear spacing between the left sides (x1, x2), midpoints (y1, y2), and right sides (z1, z2) of adjacent strips in inches. See **Figure 1** below. All measurements are parallel to a lane line so one point will need to be "projected" along a line perpendicular to a lane line and passing through the point before a longitudinal clear spacing value can be correctly determined.

6.5. For lateral displacement, record whether either end of any of the three strips overlaps a lane line.

6.6. Return the three rumble strips to their initial (undisturbed) location.

6.7. Repeat **steps 6.1 through 6.6** using the same truck to make 40 passes at 57.5 mph, then 37.5 mph, and finally 22.5 mph.

6.8. Once all 160 passes of the truck are complete, repeat **steps 6.1 through 6.6** using the test car to make 40 passes each at 67.5 mph, 57.5 mph, 37.5 mph, and finally 22.5 mph.

Note: At each traverse speed of the test car, peak sound will be measured during ten of the 40 passes. See **Section 7**.

7. TEST PROCEDURE – SOUND (PASSENGER CAR ONLY)

7.1. Before testing begins with the test car, determine which ten of the 40 passes at each traverse speed will be used in the measurement of peak sound. It is recommended that these 10 passes be distributed roughly equally throughout the total of 40 passes. Only the peak sound values recorded during these predetermined passes will be used during ensuing calculations.

7.2. Record peak sound for 10 passes at each traverse speed using the sound level meter positioned as described in **subsection 5.5**.

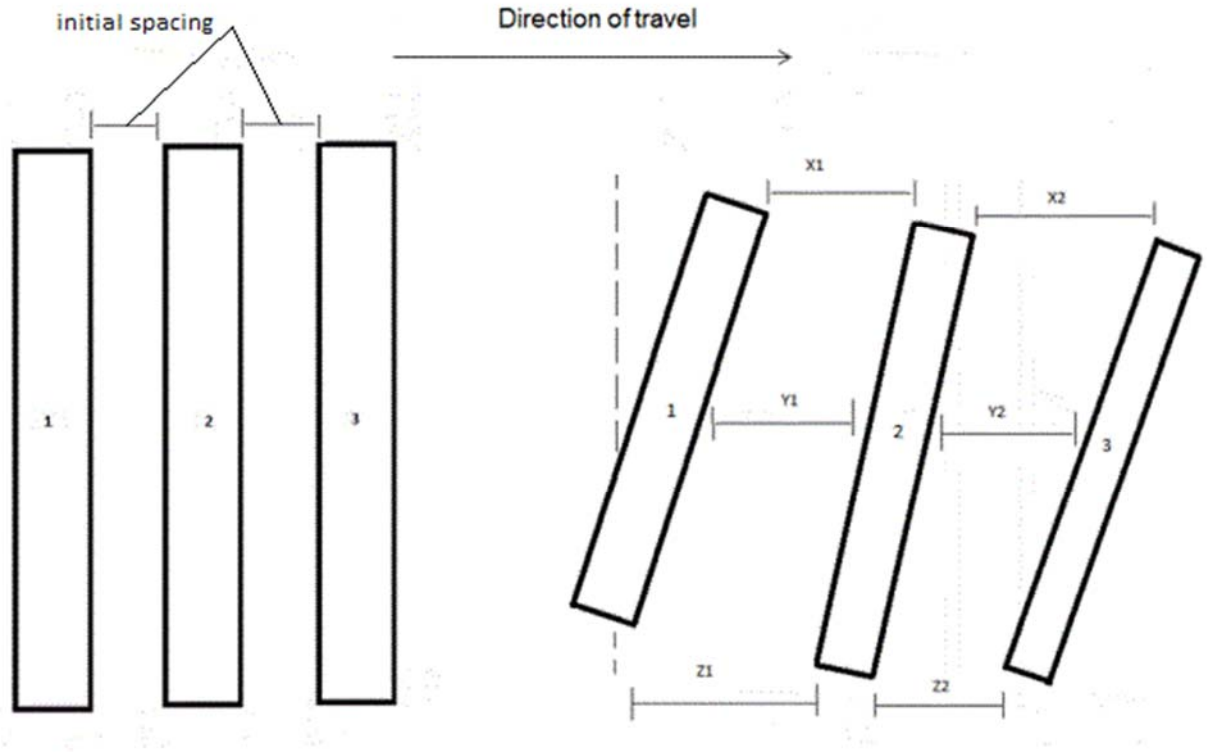

Figure 1

8. CALCULATIONS

8.1. Average Relative Longitudinal Movement (ARLM). Calculate an ARLM for the left side, midpoint, and right side of the strip group for each traverse speed and test vehicle.

$ARLM_{y,s,m} = [(m1_f - m1_i) + (m2_f - m2_f)] / 2$ where,

y = test vehicle = t (truck), p (passenger car)
s = traverse speed (mph)
$m1_f$, $m1_i$, $m2_f$, $m2_i$ = clear spacing values determined in **step 6.4** (inches)
m = x (left side), y (midpoint), z (right side) as shown in **Figure 1**
i = initial (undisturbed) spacing between panels (as per manufacturer's recommendations)
f = final (disturbed) spacing between panels after 40 passes
1 = 1st bay between strip 1 and 2, see **Figure 1**
2 = 2nd bay between strip 2 and 3, see **Figure 1**
Note: Resultant ARLM values can be either (+) or (-).

8.2. Average Rotation (AROT). Calculate AROT using the left and right corner longitudinal displacement data for each strip collected in **step 6.3**, the length of the rumble strips (inches), and trigonometry. With respect to the left edge of the strip, counterclockwise rotations are positive (+), clockwise rotations are negative (-).

$AROT_{y,s} = (ROT_1 + ROT_2 + ROT_3) / 3$ where,

y = test vehicle = t (truck), p (passenger car)
s = traverse speed (mph)
ROT_1, ROT_2, ROT_3 = rotation of strip 1, 2, & 3 (± degrees)
Note: Pay attention to sign in the above calculation

8.3. Average Peak Sound. Calculate Average Peak Sound (APS) using data collected in **step 7.2** for each traverse speed of the passenger vehicle.

$APS_s = \sum PS_{1-10} / 10$ where,

s = traverse speed (mph)
$\sum PS_{1-10}$ = sum of the peak sounds for the 1st thru the 10th recorded pass (dB)

9. REPORT

9.1. Provide the following:

9.1.1. Product data.

9.1.2. Photographs and descriptions of test vehicles, including axle loads for test truck.

9.1.3. Product and performance data of sound level meter.

9.1.4. Photographs and a description of the fully set-up test area.

After 40 passes of each test vehicle and each traverse speed, provide:

9.1.5. Photographs described in **subsection 6.2**.

9.1.6. Longitudinal displacement data from **subsection 6.3**.

9.1.7. Longitudinal clear spacing data from **subsection 6.4**.

9.1.8. A description of lateral displacement in relation to lane lines (**subsection 6.5**).

9.1.9. Peak sound values (passenger car only) from **subsection 7.2**.

9.1.10. Tabulations of calculated values for ARLM, AROT and APS for each applicable test vehicle and traverse speed, as defined in **subsections 8.1, 8.2 and 8.3**.