



Designation: E2176 – 08

Standard Test Method for Measuring the Coefficient of Retroreflected Luminance of Pavement Markings in a Standard Condition of Continuous Wetting (R_{L-Rain})¹

This standard is issued under the fixed designation E2176; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a measurement of the wet retroreflective (R_{L-Rain}) properties of horizontal pavement marking materials, such as traffic stripes and road surface symbols.

1.2 This method of measuring wet retroreflective properties (R_L) of pavement markings utilizes a method of continuously wetting the marking during measurement (see Fig. 1).

NOTE 1—Test Method E2177 may be used to describe the retroreflective properties of pavement markings in conditions of wetness after a period of rain.

1.3 This test method is most suitable for laboratory use under controlled conditions, but may also be used for field measurements when the necessary controls and precautions are followed.

1.4 This test method specifies the use of reflectometers that can measure pavement markings per Test Method E1710.² The entrance and observation angles required of the retroreflectometer in this test method are commonly referred to as “30 meter geometry.”²

1.5 This test method has been shown to produce reasonable results for pavement marking systems with optics having an index of refraction greater than 2.0 and structured markings having vertical structures greater than or equal to 3 mm.³ Users should exercise caution when using this test method for

pavement marking systems with optics having an index of refraction less than 2.0 or markings having vertical structures less than 3 mm.

1.6 Results obtained using this test method should not be the sole basis for specifying and assessing the wet retroreflective effectiveness of pavement marking systems. Users should complement the results of this test method with other evaluation results, such as nighttime visual inspections.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 2—An alternative test method designed to better represent the retroreflective efficiency of pavement marking systems under typical rain events is under development.

2. Referenced Documents

2.1 ASTM Standards:⁴

- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- E965 Test Method for Measuring Pavement Macrot texture Depth Using a Volumetric Technique
- E1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
- E2177 Test Method for Measuring the Coefficient of Retroreflected Luminance (R_L) of Pavement Markings in a Standard Condition of Wetness

3. Terminology

3.1 *coefficient of retroreflected luminance, R_L* —the ratio of the luminance, L , of a projected surface to the normal illuminance, E , at the surface on a plane normal to the incident light, expressed in candelas per square metre per lux [(cd·m⁻²)/lx]. Because of the low luminance of pavement markings,

¹ This test method is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.10 on Retroreflection.

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² Reference ASTM E1710. The standard measurement condition is intended to represent the angles corresponding to a distance of 30 m for the driver of a passenger car with an eye height of 1.2 m and a headlight height of 0.65 m above the road. See Appendix X1.

³ The 3 mm minimum vertical structure height is based on a survey of materials evaluated and reported on in: FHWA/VTRC 05-CR3 Wet Night Visibility of Pavement Markings, VTRC (October 2004), FHWA/TX-06/0-5008-1 Evaluation of Wet-Weather Pavement Markings, First Year Report, TTI (Sept 2005), FHWA/TX-07/0-5008-2 Evaluation of Wet-Weather and Contrast Pavement Markings, Final Report, TTI (Aug 2007).

⁴ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

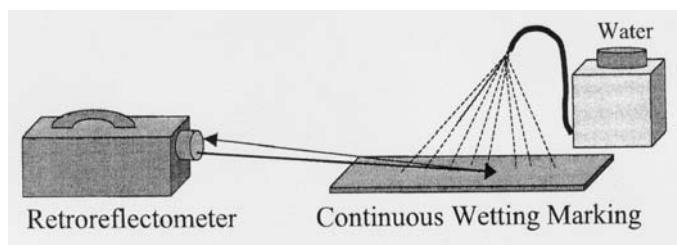


FIG. 1 Illustration of Measurement

the units commonly used are millicandelas per square metre per lux [(mcd·m⁻²)/lx].

3.2 *conditions of continuous wetting*—the test condition is created by artificially creating rain by using a rain simulator such as a portable hand sprayer.

3.3 *external beam retroreflectometers*—retroreflectometers that illuminate a measurement area outside of the instruments body.

3.4 *internal beam retroreflectometers*—retroreflectometers that illuminate a measurement area inside of the instruments body.

3.5 *portable retroreflector*—an instrument that can be used in the field or laboratory for measuring the coefficient of retroreflected luminance, R_L .

3.6 R_{L-Rain} —the steady state retroreflectance value, R_L , obtained while the marking is being continuously wetted during the measurement (Fig. 2).

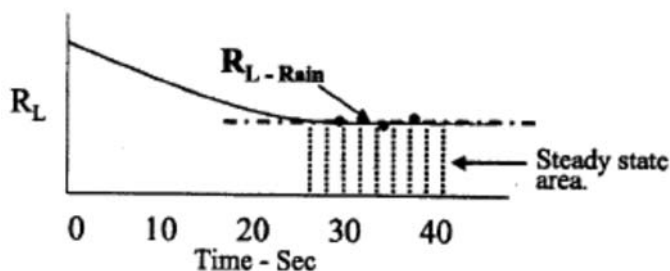


FIG. 2 Definition of R_{L-Rain}

4. Significance and Use

4.1 The coefficient of retroreflected luminance, R_L , is the property of a pavement marking system that provides a measure of the retroreflective efficiency of the marking and depends on factors such as the materials used, age, and wear pattern. These conditions shall be observed and noted by the user.

4.2 Under identical conditions of headlight illumination and driver's viewing, larger values of R_L correspond to higher levels of visibility at corresponding geometry.

4.3 The pavement marking's measured retroreflective efficiency in conditions of continuous wetting may be used to characterize the properties of the marking on the road as water is continuously falling on it. The retroreflective efficiency of the marking in conditions of continuous wetting may be different than in dry, wet or damp conditions.

4.4 This test method may produce measurements of R_{L-Rain} for pavement marking systems that do not correlate to night-time visibility distance during typical rain events. The rainfall intensity simulated by this test method is significantly greater than most ordinary or even heavy rainfall events. As a result, the test specimen, unless it has vertical features exceeding 3 mm, becomes flooded. Optics with an index of refraction less than 2.0 are practically ineffective when immersed in water. Thus, the test method is of limited applicability for assessing the wet retroreflective properties of pavement marking systems having vertical features less than 3 mm or optics having an index of refraction less than 2.0.

4.5 Retroreflectivity of pavement (road) markings degrades with traffic wear and requires periodic measurement to ensure that sufficient line visibility is provided to drivers.

4.6 Newly installed pavement markings may have a natural surface tension or release agents which prevent wetting of the marking by rain/water. This phenomenon produces unreliable and unrepeatable results when measuring retroreflective efficiency under wet conditions. This non-wetting phenomenon is generally eliminated after one month of wear and weathering on the road. A wetting agent can be used to estimate the R_{L-Rain} properties of new markings (see 5.4).

4.7 Roadway characteristics such as longitudinal slope, cross slope and pavement porosity will impact the results of this test method.

5. Apparatus

5.1 Retroreflector:

5.1.1 The retroreflector shall be an external beam instrument and shall be designed and constructed so that stray light will not affect the reading.

5.1.2 The retroreflector shall meet the requirements of Test Method E1710 (see Appendix X1).

5.2 Retroreflector Setup—Rain/Water Shield:

5.2.1 The retroreflector, if necessary, shall be modified with a rain/water shield to protect its lens from splattering rain/water during wet measurement.

5.2.2 Adjust the shield such that it does not block the projected light and diminish readings. Determine area of marking being illuminated with the projected light. Adjust shield so that it does not cover any of this area and thus prevent complete wetting.

5.3 Rain Simulator (Water Sprayer):

5.3.1 The recommended rain simulator is a 8 L (2 gal) minimum capacity, adjustable nozzle garden sprayer. The rate of water spray should be approximately 0.8 L/min. A battery operated sprayer performs the best since the battery allows a constant rate/volume of water spray.

5.3.2 Clean tap water shall be used.

5.4 Wetting Agent:

5.4.1 The use of a wetting agent as explained herein is not a standard test procedure. However, the use of a wetting agent may be a practical way to estimate the performance of newly installed markings.