



Designation: E 2176 – 01

# Standard Test Method for Measuring the Coefficient of Retroreflected Luminance ( $R_L$ ) of Pavement Markings in a Standard Condition of Continuous Wetting<sup>1</sup>

This standard is issued under the fixed designation E 2176; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the measurement of the wet retroreflective ( $R_L$ ) properties of horizontal pavement marking materials, such as traffic stripes and road surface symbols, using a portable or mobile retroreflector that can be placed on or before the road marking to measure the retroreflection at the prescribed geometry.

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

NOTE 1—Test Method E 2177 may be used to describe the performance of pavement markings in conditions of wetness after a period of rain.

1.3 This test method specifies the use of portable or mobile reflectometers that can measure pavement markings per Test Method E 1710.<sup>2</sup> The entrance and observation angles required of the retroreflector in this test method are commonly referred to as “30 meter geometry.”<sup>2</sup>

1.4 This test method is intended to be used for field measurement of pavement markings but may be used to measure the performance of materials on sample panels before placing the marking material in the field.

1.5 *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.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 6359 Specification for Minimum Retroreflectance of

<sup>1</sup> 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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<sup>2</sup> Reference ASTM E 1710 “Standard Test Method for Measurement of Retroreflective Pavement Markings with CEN-Prescribed Geometry Using a Portable Retroreflector.” 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.

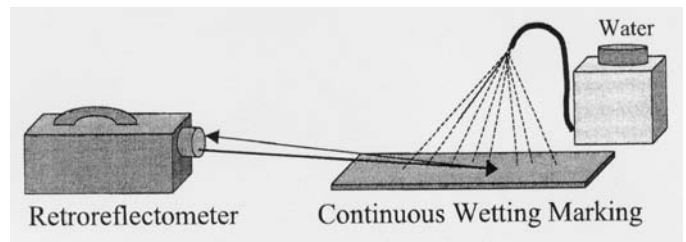


FIG. 1 Illustration of Measurement

Newly Applied Pavement Marking Using Portable Hand-Operated Instruments<sup>3</sup>

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method<sup>4</sup>

E 965 Test Method for Measuring Pavement Macrotecture Depth Using a Volumetric Technique<sup>3</sup>

E 1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflector<sup>5</sup>

E 2177 Test Method for Measuring the Coefficient of Retroreflected Luminance ( $R_L$ ) of Pavement Markings in a Standard Condition of Wetness<sup>5</sup>

### 2.2 Other Standards:

CEN-EN 1436 Road Marking Materials—Road Marking Performance for Road Users<sup>6</sup>

## 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<sup>-2</sup>)/lx]. Because of the low luminance of pavement markings, the units commonly used are millicandelas per square metre per lux [(mcd·m<sup>-2</sup>)/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.

<sup>3</sup> Annual Book of ASTM Standards, Vol 04.03.

<sup>4</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>5</sup> Annual Book of ASTM Standards, Vol 06.01.

<sup>6</sup> Available from European Committee for Standardization, Central Secretariat (CEN), rue de Stassart 36, B1050, Brussels, Belgium.

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 *mobile retroreflector*—a retroreflector that has been mounted to a vehicle for purposes of taking measurements while the vehicle is moving.

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

3.7  $R_{L-Rain}$ —The retroreflectance value,  $R_L$ , obtained while the marking is being continuously wetted during the measurement. See graph (Fig. 2). The value recorded is the average of two to three readings in the steady state area.

#### 4. Significance and Use

4.1 The quality of the pavement marking is determined by the coefficient of retroreflected luminance,  $R_L$ , be it dry or wet, and depends on 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 visual performance at corresponding geometry.

4.3 The pavement marking's measured performance in conditions of continuous wetting may be used to characterize the performance of the marking on the road as water is continuously falling on it and may be representative to a period of rain. This performance of the marking may be different than that experienced when the markings are just wet or damp.

4.4 Retroreflectivity of pavement (road) markings degrades with traffic wear and requires periodic measurement to ensure that sufficient line visibility is provided to drivers. For example see Specification D 6359 for dry reflectivity requirements.

4.5 For a given viewing distance, measurements of  $R_L$  made with a retroreflector having a geometry corresponding to that viewing distance are a good indicator of the visual ranking of the material measured.

4.6 As specified by Test Method E 1710, the measurement geometry of the instrument is based on a viewing distance of 30 m, an eye height of 1.2 m and a headlight mounting height of 0.65 m (see Appendix X1).

4.7 Newly installed pavement markings may have a natural surface tension or release agents which prevent the wetting out

of the product by rain/water. This phenomenon produces an interference when assessing the wet characteristics of a pavement marking. Attempt to measure markings with this surface "non-wetting" of the water may give higher values. This condition is short lived and markings that have been on the road for one month or more do not exhibit this non-wetting.

4.8 It shall be the responsibility of the user to employ an instrument having the specified observation and entrance angles.

#### 5. Apparatus

##### 5.1 Retroreflector—Portable or Mobile:

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 E 1710.

##### 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 rain maker (simulator) shall be 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 *Discussion*—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.

5.4.2 In that newly installed pavement markings may have a natural surface tension or release agents which prevent the wetting out of the product by rain/water, a practical method can be used to estimate the performance of newly placed markings. The addition of a small amount of soap or surfactant to the water in the sprayer eliminates this interference without damage to the installed line or sample panel. Recommended solution mixtures are: (a) 0.10 % by volume liquid soap solution; and (b) a fluorocarbon surfactant solution, 1 mL in 8 L.

NOTE 2—Pavement markings that have been installed on the road for one month prior to testing usually do not exhibit this non-wetting phenomena. When testing new markings using the soap/surfactant agents above, visually examine the appearance of the marking as the water is applied. The water should not form small beads of water on top of the marking. If small beads are formed, increase the soap/surfactant level slightly and retry.

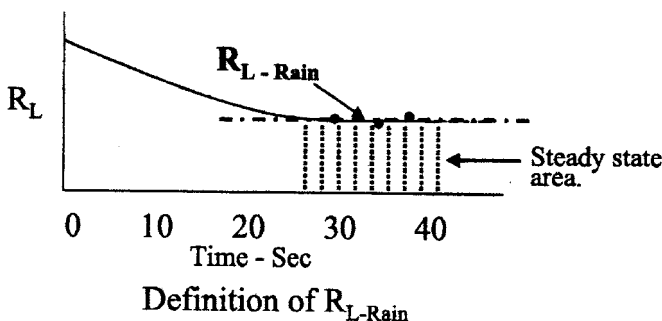


FIG. 2 Definition of  $R_{L-Rain}$