Kansas
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Brighter Signs Can Make Your Roads Safer at Night

How Do You Inspect Your Traffic Signs' Reflectivity?

By Hemin J. Mohammed, Ph.D. - Kansas LTAP

In 2012, the number of fatalities in motor vehicle traffic crashes in the United States was 33,561 [1]. About 50 percent of fatalities occur during nighttime hours, but only around 25 percent of travel is performed at night making nighttime fatalities over-represented.

There could be several reasons for this over-representation, such as driving under the influence of alcohol and drugs, fatigue, or drowsiness, but it is sensible to expect that another factor is the visibility of traffic signs to drivers at night, because traffic signs represent the main means of communicating critical information to road users [1]. The effectiveness of traffic signs depends substantially on maintaining their visibility during both daytime and nighttime conditions.

Introduction

This fact sheet discusses five methods of assessing the retroreflectivity of traffic signs, or their ability to be seen in dark conditions. Retroreflectivity is a passive technology used for pavement markings and signage and requires lighting to function properly [2]. In this fact sheet, we will give extra emphasis to the Retroreflectivity Measurement Method, because Kansas LTAP has a retroreflectometer available as part of its Equipment Loan Program, free of charge, with hands-on training to local agencies.

Basic Principles for Design and Use of Traffic Control Devices

The basic principles that govern the design and use of traffic control devices, such as signs, for all roadways open to the public in the United States are provided by The Manual on Uniform Traffic Control Devices (MUTCD) [3]. Accordingly, in 1993 [3] the U.S. Congress directed the Secretary of Transportation to revise the MUTCD to include "a standard for a minimum level of retroreflectivity that must be maintained for pavement markings and signs, which shall apply to all roads open to public travel." [4]. The purpose of this revision was to improve safety and mobility by assisting with the nighttime visibility needs of drivers, especially older drivers whose visual capabilities are declining. The importance of improving the reflectivity of signs coincides with the fact that the number of older drivers is expected to increase significantly in the following years. As of 1999, 26.8 million drivers in the United States were 65 years and older, but this number increased (by 55.6 percent) to more than 41.7 million in 2016 [5].

What is Retroreflectivity?

Retroreflection occurs when a surface returns a large portion of the directed light beam back to the light source. The object's brightness depends on the intensity of the light striking the object and the materials that make up the object. The sheeting on traffic signs returns the light from a vehicle's headlights to the driver's eyes, so the traffic signs can be seen in dark conditions. This technology has changed dramatically in the last few years as breakthroughs in retroreflective science have been adopted by many government agencies.

What Is Measured?

To fulfill the congressional decree, FHWA added a table (Table 2A-3) containing minimum sign retroreflectivity values to section 2A.08 of the 2009 MUTCD. It requires agencies to use a maintenance method that is designed to maintain traffic signs at or above minimum levels of retroreflectivity [3, 6]. The unit of measuring retroreflectivity of traffic signs is the Coefficient of Retroreflection (RA), which is the ratio of the coefficient of luminous intensity of a plane retroreflecting surface to its area expressed in candelas per lux per square meter (cd/lx/m2).

The Table is complex and to clarify how to use it, we we will take two examples [7]

Example 1: Assessing Retroreflectivity of a Curve Warning Sign

- Sign Color: black on yellow
- Sheet Type:
  - (Y*) Type I should not be used
  - Any other type is okay and should have a yellow (Y) retro level of 50 or 75
- Since a curve warning sign is a Bold Symbol and is not text or a fine symbol, it should meet retro level50 (see footnote #2)
- Black is not a retroreflective color. Therefore, its measurement is not required.

Example 2: Assessing retroreflectivity of a Stop Sign

- Sign Color: White on Red
- Sheet Type: Any type sheeting meets initial requirements
- Both white and red have to meet retro levels: White should be greater than or equal to 35, Red should be greater than or equl to 7
- Contrast ratio should be greater than or equal to 3:1 (e.g. when red equals 20, white must be greater than or equal to 60) (see footnote #3)

Table 2A-3. Minimum Maintained Retroreflectivity Levels [8]

Sign Color	Sheeting Type (ASTM D4956-04)				Additional Criteria
	Beaded Sheeting			Prismatic Sheeting	
	I	II	III	III, IV, VI, VII, VIII, IX, X	
White on Green	W*; G ≥ 7	W*; G ≥ 15	W*; G ≥ 25	W ≥ 250; G ≥ 25	Overhead
	W*; G ≥ 7	W ≥ 120; G ≥ 15			Post-mounted
Black on Yellow or Black on Orange	Y*; O*	Y ≥ 50; O ≥ 50			[2]
	Y*; O*	Y ≥ 75; O ≥ 75			[3]
White on Red	W ≥ 35; R ≥ 7				[4]
Black on White	W ≥ 50				–

[1] The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m² measured at an observation angle of 0.2° and an entrance angle of -4.0°.
[2] For text and fine symbol signs measuring at least 48 inches and for all sizes of bold symbol signs
[3] For text and fine symbol signs measuring less than 48 inches
[4] Minimum sign contrast ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity)
* This sheeting type shall not be used for this color for this application.

Bold Symbol Signs

• W1-1,2 – Turn and Curve • W1-3,4 – Reverse Turn and Curve • W1-5 – Winding Road • W1-6,7 – Large Arrow • W1-8 – Chevron • W1-10 – Intersection in Curve • W1-11 – Hairpin Curve • W1-15 – 270 Degree Loop • W2-1 – Cross Road • W2-2,3 – Side Road • W2-4,5 – T and Y Intersection • W2-6 – Circular Intersection • W2-7,8 – Double Side Roads	• W3-1 – Stop Ahead • W3-2 – Yield Ahead • W3-3 – Signal Ahead • W4-1 – Merge • W4-2 – Lane Ends • W4-3 – Added Lane • W4-5 – Entering Roadway Merge • W4-6 – Entering Roadway Added Lane • W6-1,2 – Divided Highway Begins and Ends • W6-3 – Two-Way Traffic • W10-1,2,3,4,11,12 – Grade Crossing Advance Warning	• W11-2 – Pedestrian Crossing • W11-3,4,16-22 – Large Animals • W11-5 – Farm Equipment • W11-6 – Snowmobile Crossing • W11-7 – Equestrian Crossing • W11-8 – Fire Station • W11-10 – Truck Crossing • W12-1 – Double Arrow • W16-5P,6P,7P – Pointing Arrow Plaques • W20-7 – Flagger • W21-1 – Worker

Fine Symbol Signs (symbol signs not listed as bold symbol signs)

Special Cases

- W3-1 – Stop Ahead: Red retroreflectivity ≥ 7
- W3-2 – Yield Ahead: Red retroreflectivity ≥ 7; White retroreflectivity ≥ 35
- W3-3 – Signal Ahead: Red retroreflectivity ≥ 7; Green retroreflectivity ≥ 7
- W3-5 – Speed Reduction: White retroreflectivity ≥ 50
- For non-diamond shaped signs, such as W14-3 (No Passing Zone), W4-4P (Cross Traffic Does Not Stop), or W13-1P,2,3,6,7 (Speed Advisory Plaques), use the largest sign dimension to determine the proper minimum retroreflectivity level.

Five Methods of Evaluating the Level of Retroreflectivity

In the MUTCD, five assessment or management methods are identified that agencies can implement to maintain the retroreflectivity of traffic signs at or above the minimum required levels. The MUTCD description of methods is provided below. These methods can be used individually or combined for the assessments [8]:

1. Visual Nighttime Inspection - The retroreflectivity of an existing sign is assessed by a trained sign inspector conducting a visual inspection from a moving vehicle during nighttime conditions. Signs that are visually identified by the inspector to have retroreflectivity below the minimum levels should be replaced.

2. Measured Sign Retroreflectivity - Sign retroreflectivity is measured using a retroreflectometer. Signs with retroreflectivity below the minimum levels should be replaced.

3. Expected Sign Life - When signs are installed, the installation date is labeled or recorded so that the age of a sign is known. The age of the sign is compared to the expected sign life. The expected sign life is based on the experience of sign retroreflectivity degradation in a geographic area compared to the minimum levels. Signs older than the expected life should be replaced.

4. Blanket Replacement - All signs in an area/ corridor or of a given type should be replaced at specified intervals. This eliminates the need to assess retroreflectivity or track the life of individual signs. The replacement interval is based on the expected sign life, compared to the minimum levels, for the shortest-life material used on the affected signs.

5. Control Signs - Replacement of signs in the field is based on the performance of a sample of control signs. The control signs might be a small sample located in a maintenance yard or a sample of signs in the field. The control signs are monitored to determine the end of retroreflective life for the associated signs. All field signs represented by the control sample should be replaced before the retroreflectivity levels of the control sample reach the minimum levels.

Two Groups of Methods

The five methods recommended in the MUTCD are divided into two groups: assessment methods and management methods.[6].

Assessment Group

The assessment group involves sending personnel out to examine and assess the retroreflective performance of signs. This can be a labor-intensive technique for some agencies.

This group includes the first two methods recommended in the MUTCD - 1) Nighttime Visual Inspections and (2) taking retroreflectivity measurements.

Management Group

The management group includes the last three methods listed in the MUTCD, (3) Expected Sign Life, (4) Blanket Replacement, and (5) Control Signs. These methods require less or no fieldwork at all but may result in replacing some traffic signs that are still serviceable in terms of retroreflectivity [9].

Agencies have the option to use any of the methods or combine different methods or parts of different methods, depending on their needs and available resources to examine and maintain the retroreflectivity of their signs. The most common ways to measure sign retroreflectivity in the field are by using two types of handheld instruments: contact instruments or non-contact instruments [9].

Contact Instruments for Measuring Retroreflectivity

Contact instruments involve physical contact of the measurement device with the traffic sign surface. The use of contact instruments provides relatively high levels of accuracy in measuring sign reflectivity, but it can be a time-consuming measurement process. Examples of this type of retroreflectometer are the RetroSign GRX Retroreflectometer and Roadvista 922.

The ASTM (formerly known as American Society for Testing and Materials) Standard Test Method E1709 - 00e1 titled “Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflectometer” specifies, in detail, the process of measuring retroreflectivity using a contact instrument [10]. The ASTM requires taking a minimum of four retroreflectivity measurements of the sign background and legend for each color. These values (obtained as an overall measurement of the retroreflectivity for each color on the sign) are compared to the minimum retroreflectivity values to determine whether the sign should be replaced [9].

Non-contact Instruments for Measuring Retroreflectivity

Non-contact instruments include both hand-held devices and vehicle-based systems that measure the sign retroreflectivity from a distance.

Non-contact instruments offer flexibility and speed-up the measurement process, but the trade-off is a lower level of accuracy. An example of this type of retroreflectometer is Impulse RM.

Advantages of Using the Retroreflectivity Method

The retroreflectivity measurement method eliminates all subjectivity that exists in other methods by providing the most direct means of monitoring the maintained retroreflectivity levels of deployed traffic signs.

Disadvantages

The major disadvantage of using the retroreflectivity measurement method is the required amount of time for measuring all of the traffic signs in a jurisdiction. In addition, this method accounts for only one aspect of a sign's appearance, which is the reflectivity. Other factors should be considered when assessing the effectiveness of a sign at a particular location including appearance, legibility, and environmental conditions, for instance, levels of visual clutter or glare, location of signs, and the complexity of the visual background. Finally, agencies need access to an appropriate instrument and trained personnel to use this method.

Training for Sign Inspection

ATSSA offers training for sign inspectors designed to meet the minimum sign retroreflectivity requirements in the MUTCD, per the guidance document FHWA-SA-07-020. (For more information go to www.atssa.com/Training/Sign-Retroreflectivity/MUTCDRulemaking).

Retroreflectometer for Loan

Kansas LTAP has a RetroSign GRX-3 retroreflectometer available for loan as part of its Equipment Loan Program for local agencies. The current cost of this device is about $10,000.

Kansas LTAP loans the device to local agencies at no charge with hands-on training. For information on this equipment and more, contact Kansas LTAP Road Safety Resource Coordinator Hemin Mohammed at hemin@ku.edu or (785) 864-6631, or go to https://kutc.ku.edu/equipment-loan-program.

References

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