Wyoming Technology Transfer Center
WY T² LTAP
Local Technical Assistance Program

T² Roads on the Range

Volume 23, Number 4 | Phone: 800-231-2815 | Fax: 307-766-6784 | wwweng.uwyo.edu/wyt2 | Winter 2008

FULL DEPTH RECYCLING DEMONSTRATION PROJECT COMPLETED IN LARAMIE

by Gregory E. Halsted

All across the Cowboy State, thousands of miles of federal, state, county, and city roads are rapidly deteriorating and in need of immediate rehabilitation. The majority of these roadways were constructed utilizing flexible-granular base materials and were often under-designed for today's heavier traffic loads. The presence of ruts, potholes, and severe cracking are common problems that are usually maintained with additional asphalt patches and thin overlays. However, these problems often are not attributed to normal surface wear and may be the result of a failed or inadequate base course. When this situation occurs, it is important to fix these base problems in order to have long-lasting pavement rehabilitation.

Salvaging these existing failed flexible pavements is a good practice, both environmentally and economically, because they still contain good granular material that, when blended with portland cement can be reused and recycled into a strong, durable new base. A process commonly referred to as full-depth reclamation (FDR) is a technique in which the old asphalt pavement and a portion of the underlying base, subbase, or subgrade materials are pulverized and blended together with portland cement to create an enhanced roadway base material. The steps for FDR consist of the pulverization of the existing materials, the incorporation of any additional materials, mixing, initial shaping of the new base mixture, compaction, final shaping, curing, and the application of a new surface or wearing course.

On October 12, 2007, an FDR demonstration project was undertaken by the University of Wyoming,

Reclaimer mixing portland cement, asphalt, and base course

under the direction of Rock Morgan, Supervisor, Construction Design/Contracts Division of Physical Plant. Other participants included Gorman Engineering, LLC (engineering and surveying services), Simons Contracting (prime contractor), ARS, Inc. (stabilization contractor), and Terracon Consultants, Inc. (testing services). The 400 foot roadway project is situated in Laramie off of Grand Avenue, adjacent to the Spanish Walks Apartments. On this particular project, the asphalt and base material had been previously removed to facilitate placement of the curb and gutter. After the material was hauled back on to the site, ARS reclaimed the materials to ensure proper mixing and sizing of the old asphalt and base course. Normally, the asphalt and base course would be reclaimed in-place.

The design called for 4% by weight of portland cement, which was placed using specially designed trucks with hoods to reduce dusting. After the cement was spread over the reclaimed base, ARS made another pass with their reclaimer to mix the cement and base, while adding a measured amount of water to control density. Finally, the newly mixed base material was shaped by a blade, and compacted using a roller to achieve final density. A wearing course of 2 inches of asphalt was subsequently placed over the FDR base course.

Refreshments for the demonstration project were provided by the Concrete Association of Wyoming. Jamie Johnson, PE, Pavement Engineer for the Rocky Mountain Cement Council, was also on hand to field questions, along with Bill Gorman, PE, Gorman Engineering and Kurt Sommermeyer, ARS. According to Rock Morgan, "the University of Wyoming wanted to try the FDR process to determine if it is a viable rehabilitation technique for failed asphalt pavements. We like the idea of recycling the asphalt and base course, saving virgin aggregate vs. conventional reconstruction."

Whether Interstate, industrial, or residential, portland cement is the key to reconstructing flexible pavements that have failed. The incorporation of the cement with the old base course material, often including the old asphalt surface, provides a versatile, practical, and cost-effective means of strengthening worn-out pavements. The cement binds the granular particles together to form a paving material capable of withstanding moisture infiltration and degradation. It increases the strength of the base without the need for removing the old material and hauling in large quantities of expensive new base materials.

The reclamation of failed flexible pavements using portland cement has many advantages: the conservation of non-renewable resources through the reuse of existing materials, the elimination for the need of new granular base materials, a reduction in both hauling and energy costs, and the elimination of bumps, dips, ruts, potholes, cracks, and preliminary patches.

More information on this subject will be presented at this year's Transportation & Safety Congress.

New MUTCD Sign
RETROREFLECTIVITY REQUIREMENTS

New MUTCD Minimum Retroreflectivity Compliance Periods

The second revision of the 2003 MUTCD introduces new language establishing minimum retroreflectivity levels that must be maintained for traffic signs. **Agencies have until January 2012, to establish and implement a sign assessment or management method to maintain minimum levels of sign retroreflectivity.** The compliance date for regulatory, warning, and ground-mounted guide signs is January 2015. For overhead guide signs and street name signs, the compliance date is January 2018. The new MUTCD language is shown on the following pages.

Traffic signs provide important information to drivers at all times, both day and night. To be effective, their visibility must be maintained. The 2003 *Manual on Uniform Traffic Control Devices* (MUTCD) addresses sign visibility in several places, including Sections 1A.03, 1A.04, 1A.05, 2A.06, 2A.08, and 2A.22. These sections address factors such as uniformity, design, placement, operation, and maintenance. Previously, the MUTCD did not specify minimum retroreflectivity levels.

The new standard in Section 2A.09 requires that agencies maintain traffic signs to a minimum level of retroreflectivity outlined in Table 2A-3 of the MUTCD. The Federal Highway Administration (FHWA) believes that this proposed change will promote safety while providing sufficient flexibility for agencies to choose a maintenance method that best matches their specific conditions. Including Table 2A-3 in the MUTCD does not imply that an agency must measure the retroreflectivity of every sign. Rather, the new MUTCD language describes five methods that agencies can use to maintain traffic sign retroreflectivity at or above the minimum levels. Agencies can choose from these methods or combine them. Agencies are allowed to develop other appropriate methods based on engineering studies. However, agencies should adopt a consistent method that produces results that correspond to the values in Table 2A-3. The new MUTCD language recognizes that there may be some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time. As long as the agency with jurisdiction is maintaining signs in accordance with Section 2A.09 of the MUTCD, the agency will be considered to be in compliance. This document describes methods that can be used to maintain sign retroreflectivity at or above the MUTCD's minimum maintained retroreflectivity levels.

NEW MUTCD SECTION 2A.09 MAINTAINING MINIMUM RETROREFLECTIVITY

Support:
Retroreflectivity is one of several factors associated with maintaining nighttime sign visibility (see Section 2A.22).

Standard:
Public agencies or officials having jurisdiction shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum levels in Table 2A-3.

Support:
Compliance with the above Standard is achieved by having a method in place and using the method to maintain the minimum levels established in Table 2A-3. Provided that an assessment or management method is being used, an agency or official having jurisdiction would be in compliance with the above

New MUTCD Table 2A-3. Minimum Maintained Retroreflectivity Levels ①

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			Ground-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 1200 mm (48 in) and for all sizes of bold symbol signs
③ For text and fine symbol signs measuring less than 1200 mm (48 in)
④ Minimum Sign Contrast Ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity)
* This sheeting type should 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
- W1-15 – 270 Degree Loop
- W2-1 – Cross Road
- W2-2, -3 – Side Road
- W2-4, -5 – T and Y Intersection
- W2-6 – Circular Intersection
- W3-1 – Stop Ahead
- W3-2 – Yield Ahead
- W3-3 – Signal Ahead
- W4-1 – Merge
- W4-2 – Lane Ends
- W4-3 – Added Lane
- 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 – Highway-Railroad Advance Warning
- W11-2 – Pedestrian Crossing
- W11-3 – Deer Crossing
- W11-4 – Cattle Crossing
- 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
- W20-7a – Flagger
- W21-1a – 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 W14-3 (No Passing Zone), W4-4p (Cross Traffic Does Not Stop), or W13-1, -2, -3, -5 (Speed Advisory Plaques), use largest sign dimension to determine proper minimum retroreflectivity level.

Standard even if there are some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time.

Guidance:
Except for those signs specifically identified in the Option portion of this Section, one or more of the following assessment or management methods should be used to maintain sign retroreflectivity:

A. 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.

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

C. **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.

D. **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.

E. **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.

F. **Other Methods** – Other methods developed based on engineering studies can be used.

Support:
Additional information about these methods is contained in the 2007 Edition of FHWA's *"Maintaining Traffic Sign Retroreflectivity"* (see Section 1A.11).

Option:
Highway agencies may exclude the following signs from the retroreflectivity maintenance guidelines described in this Section:

A. Parking, Standing, and Stopping signs (R7 and R8 series)
B. Walking/Hitchhiking/Crossing signs (R9 series, R10-1 through R10-4b)
C. Adopt-A-Highway signs
D. All signs with blue or brown backgrounds
E. Bikeway signs that are intended for exclusive use by bicyclists or pedestrians

FHWA GUIDELINES FOR RETROREFLECTIVITY MAINTENANCE

The MUTCD describes two basic types of methods that agencies can use to maintain sign retroreflectivity at or above the MUTCD minimum maintained retroreflectivity levels—assessment methods and management methods. The FHWA has identified and listed assessment and management methods for maintaining sign retroreflectivity in accordance with Section 2A.09. These methods are described beginning on page three. A full report on these methods can be found at www.fhwa.dot.gov/retro.

ASSESSMENT METHODS

Assessment methods require evaluation of individual signs within an agency's jurisdiction. There

are two basic assessment methods — visual assessment and measured sign retroreflectivity.

1. Visual Assessment

Nighttime Inspection

In the visual nighttime inspection method, on-the-fly assessments of retroreflectivity are made by an inspector during nighttime conditions. The following recommendations provide general guidance for the inspections:

- Develop guidelines and procedures for inspectors to use in conducting the nighttime inspections and train inspectors in the use of these procedures.
- Conduct inspections at normal speed from the travel lane(s).
- Conduct inspections using low-beam headlights while minimizing interior vehicle lighting.
- Evaluate signs at typical viewing distances so that adequate time is available for an appropriate driving response.

One or more of the following procedures should be used to support visual inspections.

Calibration Signs Procedure

In this procedure, an inspector views a "calibration sign" prior to conducting the nighttime inspection described above. Calibration signs have known retroreflectivity levels at or above minimum levels. These signs are set up where the inspector can view the calibration signs in a manner similar to nighttime field inspections. The inspector uses the visual appearance of the calibration sign to establish the evaluation threshold for that night's inspection activities. The following factors provide additional information on the use of this procedure:

- Calibration signs are needed for each color of sign in Table 2A-3.
- Calibration signs are viewed at typical viewing distances using the inspection vehicle.
- Calibration signs need to be properly stored between inspections so that their retroreflectivity does not deteriorate over time.
- Calibration sign retroreflectivity should be verified periodically.

Comparison Panels Procedure

Comparison panels are used to assess signs that have marginal retroreflectivity. The comparison panels are fabricated at retroreflectivity levels at or above the minimum levels. When the visual inspection identifies the retroreflectivity of a sign as marginal, a comparison panel is attached to the sign and the sign/panel combination is viewed and compared by the inspector.

Consistent Parameters Procedure

Nighttime inspections are conducted under similar factors that were used in the research to develop the minimum retroreflectivity levels. These factors include:

- Using a sport utility vehicle or pick-up truck to conduct the inspection.
- Using a model year 2000 or newer vehicle for the inspection.
- Using an inspector who is at least 60 years old.

2. Measured Sign Retroreflectivity

In this method the retroreflectivity of a sign is measured and directly compared to the minimum level appropriate for that sign. ASTM E1709, Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflectometer, provides a standard method for measuring sign retroreflectivity.

MANAGEMENT METHODS

Management methods provide an agency with the ability to maintain sign retroreflectivity without having to assess individual signs. There are three basic management methods — sign replacement based on expected sign life, blanket replacement of large numbers of signs at appropriate intervals, and use of control signs.

1. Expected Sign Life

In this method, individual signs are replaced before they reach the end of their expected service life, which is the time anticipated for the retroreflective material to degrade to the appropriate minimum level. Expected service life can be based on sign sheeting warranties, weathering deck results, measurements of field signs, or other criteria.

This method requires a system for tracking sign age. A common approach for identifying the age of individual signs uses a label on the sign to mark the year of fabrication or installation. Sign management systems can also be used to track the age of individual signs.

2. Blanket Replacement

With this method, an agency replaces all signs in an area, or of a given type, at specified time intervals based on the relevant expected sign life. This method typically requires that all of the designated signs within a replacement area, or of the particular sign type, be replaced even if a sign was recently installed.

An agency can choose to use either an assessment method or a management method, or a combination of the two. Agencies may develop other methods as long as they are documented in an engineering study and correspond to the values in Table 2A-3.

3. Control Signs

In this method, a control sample of signs is used to represent all of an agency's signs. The retroreflectivity of the control signs is monitored and sign replacement is based on the performance of the control signs.

- Agencies should develop a sampling plan to determine the appropriate number and type of control signs needed to represent the agency's signs.
- Control signs may be actual signs in the field or signs in a maintenance yard (for convenience).
- The retroreflectivity of the control signs should be monitored using an assessment method.

Reprinted from FHWA document No. FHWA-SA-07-020.

Retroreflectivity Loan Program

The T²/LTAP Center has two retroreflectometers that can be loaned to cities and counties to help them determine the retroreflectivity levels of their signs. For more information, please call 800-231-2815 or 307-766-6743.

Soil & Fill Density Control
Douglas - March 4
Lander - March 5

Safety Congress
Casper - April 2 & 3

Work Zone Safety & Flagger Certification
Lander - April 30 & May 1
Laramie - May 12 & 13
Douglas May 14 & 15

Wyoming T²/LTAP Staff:

Khaled Ksaibati, Ph.D., P.E.
Director

George Huntington, P.E.
Senior Engineer

Mary Harman
Executive Assistant

Alli Boomgaarden,
Chris Eyre & Alex Literati
Student Assistants

The national Local Technical Assistance Program mission is to foster a safe, efficient, and environmentally sound surface transportation system by improving skills and increasing knowledge of the transportation workforce and decision makers.

The Wyoming T² Newsletter is produced by the Wyoming Technology Transfer Center at the University of Wyoming. The T² Center is financially supported by the Federal Highway Administration, Wyoming Department of Transportation, University of Wyoming, and the Cities and Counties of the State of Wyoming. Any opinions, findings, conclusions, or recommendations presented in the T² Newsletter are those of the authors and do not necessarily reflect the views of the supporting organizations. Any products mentioned are for informational purposes only and should not be considered as product endorsements.

Wyoming Technology Transfer Center
1000 E. University Avenue, Dept. 3295
Laramie, WY 82071

Pre-Sorted Standard
U.S. Postage Paid
Laramie, WY 82072
Permit No. 1