Session 123
Rumble Stripes: Opportunity to Improve Safety and Retroreflectivity

Presented
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by
Alan Plunkett, INDOT
Bill Smith, INDOT
Tom Brennan, Purdue
US-231 MOTIVATION FOR INSTALLATION OF CENTER AND EDGE LINE RUMBLE STRIPES
DISLODGED RAISED PAVEMENT MARKERS
INDOT Struck by Loose RPM, Picture from Stacey Flick

- January 2011
- LaPorte District
FHWA SAFETY COUNTERMEASURES
Longitudinal Rumble Strips and Stripes on 2-Lane Roads
FHWA SAFETY COUNTERMEASURES
Longitudinal Rumble Strips and Stripes on 2-Lane Roads
SAFETY BENEFITS
Longitudinal Rumble Strips on 2-Lane Roads

- Center line rumble strips on two-lane roads
  - Provide a **45% reduction** of head on / fatal and injury crashes

- Edgeline rumble strips on two-lane roads
  - Provide a **35% Reduction** of target crashes
SAFETY BENEFITS

Tactile and Audible Responses to Vehicle Leaving Lane

- Alerting distracted, drowsy drivers
- Providing Indication of Lane Location during adverse weather conditions
SAFETY BENEFITS

Tactile and Audible Responses to Vehicle Leaving Lane

Corrected Incursion (Northbound)

Corrected Incursion (Southbound)
SAFETY BENEFITS
Tactile and Audible Reponses to Vehicle Leaving Lane
• Three notable incidents occurred between April and May 2012, two of which were fatal head-on crashes.
FIELD DEPLOYMENT ON US231

Typical Existing Pavement Marking/Lane Layout Retrofit

- Contract Letting: 8/8/12
- Completion: 10/31/12

| 11’ 0” | 4” White Line |
|        | 4” LINE 8” SPACE 4” LINE |
|        | Existing RPM |

~3’ ~30’ ~3’
FIELD DEPLOYMENT ON US 231

Installation Limits

- US-231 is a two lane rural highway
- ADT > 8,000 VPD between Lafayette and Crawfordsville

Project Limits ~18.5 Miles

Not placed in towns due to low speed conditions

Romney
Linden

CR 500 S
US-231
Special Provisions

Section 12.1: Summary Special Provisions from Contract R-35162:

CRAWFORDSVILLE DISTRICT Contract No. R-35162 (PAGES 81-84)

SECTION 122 - FOG SEAL

412.61 Description
The work shall consist of applying asphalt emulsion to the pavement surface in accordance with 105.03.

412.62 Materials
Materials shall be in accordance with the following:
Asphalt Emulsion, AL-F ......................................................... 902.01(b)
Fine Aggregate ................................................................. 804.02

CONSTRUCTION REQUIREMENTS

412.63 Equipment
A distributor in accordance with 409.03(a) shall be used.

412.64 Weather Limitations
Fog seal operations shall not be conducted on a wet pavement, when the ambient air or pavement temperature is below 60°F, or under other unsuitable conditions exist, unless approved by the Engineer.

412.65 Preparation of Surface
Surfaces shall be clean and free of any foreign or loose material. All cuttings, detour housing, and shrinkable cracks shall be sealed prior to application of the fog seal. That is, clearances shall be removed prior to opening to traffic.

412.66 Application of Asphalt Material
The asphalt material shall be applied uniformly at the rate of 0.06 - 0.07 gallon per yard. Asphalt material shall be applied such as to ensure even and uniform coverage to the pavement surface.

412.67 Prevention of Surface
Fine aggregate or other approved binding material shall be applied to pedestrian crosswalks, driveways, or other areas as directed by the Engineer. Brooming of paved areas shall be performed prior to opening to traffic on treated surfaces, as directed. Traffic shall be permitted on the freshly treated surfaces until the asphalt material has sufficiently cured to prevent Brazing.

412.68 Method of Measurement
Fog seal will be measured by the square yard complete in place.

Pay Item Pay Unit Symbol
Fog Seal

CENTRELINE AND EDGE LINE CORRUGATIONS

The cost of installing centreline and edge line corrugations shall be paid for as ‘Milled Centerline Corrugations’.

CENTRELINE TRAFFIC CONTROL

Some centreline operations will require equipment to be over the centreline (in both lanes). A minimum of four total lanes will be required during these operations (2 flagmen to control traffic and 2 flagmen to flag near the equipment).

PAVEMENT MARKINGS

The Contractor shall make the record of the existing pavement markings so that such markings may be replicated later. This record shall show longitudinal and transverse dimensions. The record must be submitted to and approved by the District Traffic Engineer prior to the removal or covering of existing pavement markings. The District Traffic Section shall be notified two weeks prior to painting or applying pavement markings so as to allow the District Traffic Section to verify the pavement marking plan. The contact person for the District Traffic Section is Nathan Anwar, Traffic Construction Liaison at 765-361-5608.

LINE, REMOVE

Existing pavement markings directed to be removed shall be removed to the fullest extent possible without materially damaging the pavement surface. Removal of existing durable pavement markings shall be removed to a level even with the existing pavement surface. Existing non-durable pavement markings directed to be removed shall be removed to the fullest extent possible without materially damaging the pavement surface. Waterblasting shall be the method used to remove existing non-durable pavement markings that are directed to be removed.

SNOWPLOWABLE RPM REMOVAL

The area disturbed during the removal of the Snowplowable RPMs shall not exceed 3 inches in depth below 3 inches from all sides of the marker base. The cutting holes from removal of the Snowplowable RPMs shall be filled with HMA. The cost of filling the holes from removal of the Snowplowable RPMs shall be included in the cost of ‘Snowplowable Raised Pavement Marker, Remove’. The holes to be filled shall be free of jagged edges and other irregularities, free from objectionable or foreign materials and have smooth and level surfaces and vertical edges at the time the holes are to be filled. Each foot shall be applied to the holes prior to filling the holes.

MILLED CENTERLINE CORRUGATIONS

Description
This work shall consist of placing milled corrugations along the centerline of the roadway in accordance with 105.03.

Construction Requirements
Milled centerline corrugations shall be constructed by cutting a series of smooth and uniform strips in consistent alignment in the pavement without damaging the surrounding pavement. Corrugations shall not be placed within the limits of PFC bridge approaches or on bridge decks. All waste material from operations shall be disposed of in accordance with 104.07.

Method of Measurement
Milled centerline corrugations will be measured by the linear foot, measured parallel to the centerline of the roadway.

Basis of Payment
Milled centerline corrugations will be paid for at the contract unit price per linear foot. Payment will be made under

Pay Item Pay Unit Symbol
Milled Centerline Corrugations............. LFT

MILLED CORRUGATION DEBRIS

All debris resulting from the installation of the milled corrugations shall require vacuum cleanup.

Fog Seal Cure Time
Fog seal shall be allowed to cure for eight (8) days prior to application of permanent pavement markings.
US-231

Detail for Recurring Special Provision

Only Gapped at:
- Public Road Approaches
- Commercial Drives
PETED RUMBLE RESEARCH AND US-231 INSTALLATION
EXAMPLE SAFETY BENEFITS

Tactile and Audible Responses to Vehicle Leaving Lane
EXAMPLE SAFETY BENEFITS
Night Time and Wet Weather Visibility
EXAMPLE SAFETY BENEFITS (INSTALL 2010)
Night Time and Wet Weather Visibility (Video)
CONSTRUCTION SEQUENCE

Approximate Sequence of Retro Fit: Picture from FHWA
INSTALLATION / EQUIPMENT

Pavement Marking Removal

Pavement Marking Grinding Machine

Grinding Head
EQUIPMENT
Rumble Milling Machine

Milling Machine
Grinding Teeth
INSTALLATION / EQUIPMENT
Pavement Marking Removal (Night Work)

Front of Milling Operation Convoy

Direction of Travel
Example Milling Machine (SR 38)
INSTALLATION / EQUIPMENT

Example Milling Machine (SR 38)

Grinding Teeth
Sweeping the Rumble Strips

1st of 2 Sweeping Trucks to Pass
INSTALLATION / EQUIPMENT
Sealing Centerline Joint after Rumbles Installed

Joint Crack Sealant
INSTALLATION / EQUIPMENT
Fog Sealant Installed on SR 38
INSTALLATION / EQUIPMENT
Fog Sealant Installed on SR 38 (VIDEO)
INSTALLATION / EQUIPMENT

Painting CLRS

Temporary Marking
PAINTED RUMBLES
Installed

Completed Paint on CLRS

Crack sealant placed prior to Fog Seal

Min 8-Day Cured Fog Seal
LESSONS LEARNED ACROSS INDIANA
2010 to Present

- Completed Paint on CLRS
- Fog Seal
- Crack sealant placed prior to Fog Seal

- Contract Letting: 8/8/12
- Completion: 10/31/12
FIELD STUDIES IN INDIANA
Paint, Thermoplastic, and Epoxy Paint

• **SR 28**  Test Installation (Initial Test): West of Frankfort, East of I-65. 4-lane divided highway. Only painted edge line rumble strips were installed on existing eastbound rumbles for both yellow and white paint. Site was also use to test standard INDOT bead mix and 3M wet-dry bead mix.

• **SR 38**  New Installation: East of Antioch, West of Kirkland. 2 Lane Rural Route. Complete installation on new asphalt including centerline joint adhesive, fog seal, and painted centerline rumble stripes.

• **US 120**  New Installation: East of US13. Complete installation on new asphalt including centerline joint adhesive, fog seal, and painted centerline rumble stripes. Centerline joint and fog seal were used.

• **US 231**  Retrofit: South of Lafayette, north of I-74. Installation on existing asphalt leaving existing RPMs in place. Edge line as well as Centerline painted rumbles were installed. Milling was performed on existing asphalt, and both the center and edge lines were joint sealed as necessary and fog sealed.

• **SR 26**  New Installation: Between SR29 and US31, west of Kokomo. 2 Lane Rural Route. Installation on new mill and paved asphalt. **Epoxy paint** on center and edge line with one **thermoplastic** test strip.
FIELD STUDIES IN INDIANA
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- **SR26** New Installation: Between SR29 and US31, west of Kokomo. 2 Lane Rural Route. Installation on new mill and paved asphalt. Thermoplastic was used instead of paint at the centerline.
PAINTED CENTERLINE
Installation Observations

Paint Appears to have de-bonded on fogseal

RPM Lens Removed
Old Edgeline Removed

Fog Sealant Used on Edgeline

New Edgeline in Rumbles
MATERIAL SELECTION FOR MARKINGS
Paint, Thermoplastic, and Epoxy Trials

• Use design manual guidance for material selection defined in Indiana Design Manual Chapter 76
MATERIAL SELECTION FOR MARKINGS
Thermoplastic on SR 26

- Consider quality control in pre-phase planning
  - Speed and methods of application
  - Material temperature/application

Higher Speed Lower Pressure Application

Pitting in Rumble

Move Even Application

Lower Speed Higher Pressure Application
MAINTENANCE OF TRAFFIC
Grinding/Milling/Sealing/Marking/Lens Removal:

• Create traffic control plan based on site specific conditions.
• Use IMUTCD, Standard Specifications and Standard Drawings for guidance to maintain moving traffic.
• Include language regarding flagging of traffic and for equipment protection in each step of the installation and operation process.
• Understand that each process varies in speed (exceeding walking speed) and restricts lane usage.
• Understand that rumbles move traffic towards operations.
Bill Smith/Alan Plunkett

CLOSING
QUESTIONS
Alan Plunkett, Bill Smith, & Tom Brennan:

INDOT 2013 Goals

1. Let an estimated 213 INDOT construction contracts valued at approximately $981MM in FY2013. Projects to be let include 44 Major New Projects valued at approximately $620MM and 169 Preservation Projects valued at approximately $361MM.

2. Implement employee training and organizational changes to improve INDOT’s project management core competency. Create, communicate and deploy a consistent method to successfully manage projects agency-wide.

3. Improve INDOT’s work zone safety program and results. Increase employee involvement, responsibility, and accountability to provide a safe work environment and reduce employee injuries and crashes.

4. Reduce the number of severe crashes on INDOT roadways. Install proven safety treatments (i.e. rumble stripes, safety edge) to reduce vehicle lane departures, especially in rural areas.

5. Develop and implement new business practices to improve agency productivity and financial accountability. Engage INDOT’s management staff to modernize service delivery while fostering INDOT’s cultural values of respect, teamwork, accountability and excellence.

SAFETY BENEFITS
Tactile and Audible Reponses to Vehicle Leaving Lane