Montana Department of Transportation
Research Programs
March 2015

**FINAL REPORT**

# PORTLAND CEMENT CONCRETE PAVEMENT (PCCP) REHABILITATION WITH DIAMOND GRIND AND PLANT MIX SEAL (PMS)

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| **Location:** | Interstate 94, C000094, Dawson County, Glendive District: Approximate Reference Point (RP) 210 to 218 |
| **Project Name:** | Glendive East & West (EB/WB) |
| **Project Number:** | IM 94-6(51)210 |
| **FHWA Project Number:** | MT 10-01 |
| **Project Type:** | This is a PCCP rehabilitation project which includes the placement of a dowel bar retrofit (DBR) and plant mix seal (PMS) course after diamond grinding |
| **Principal Investigator:** | Craig Abernathy, Experimental Program Manager (ExPM) |
| **Date of Documentation:** | **Construction**: September 2010 (EB), July 2011 (WB) - **Site Inspections**: March 2012, April 2013, April 2014, and March 2015 |

## Objective

Determine the effectiveness and durability of bond in applying a 16mm (.625") plant mix seal (PMS) to rehabilitated PCCP with a diamond grind. In addition to determine if a PMS has the potential to reduce the winter maintenance costs (labor and material) as projected by 80% as compared to PCCP. Prior to this project the current District's averages based on interstate winter maintenance costs (per mile) for PCCP is $1,486.00 as compared to $265.00 for plant mix surfacing.

## Experimental Design

Application of a PCCP rehabilitation incorporating a dowel bar retrofit, diamond grind resurfacing, and PMS course. Document construction practice on both east and westbound lanes. Document examples of visual distress which may include but not limited to rut, debonding, cracking, stripping, etc. The entire length of the project will be generally inspected to report on any pronounced distress or anomalies.

## Evaluation Process

Research will document the construction project to record a representative practice of activities prior to application of the PMS (dowel bar retrofit, diamond grind, etc.). The PMS application will be documented with an emphasis to report on the practice and to determine if areas of placement conformed to proper application and to record those portions which may have not been placed correctly to delineate on site and as not to be included in the overall analysis. To date there has been no report to Research of any inconsistencies with construction of the project during the 2010 and 2011 construction.

Research will inspect/evaluate the project at a minimum annually to document performance of the PMS (more if there is an incident with the project that requires formal reporting). All information pertaining to the performance of the PMS (including official documentation by district personnel, safety data, anecdotal, etc.) will be included in the annual and final reports when made available. All project information generated will be posted at: http://www.mdt.mt.gov/research/projects/plantmix.shtml.

**Note:** This report begins with the description of the diamond grind phase however it should be noted that the dowel bar retrofit process precedes the grinding stage with the PMS course application as the last procedure.

The following are representative images of the construction and annual site inspections beginning in the summer of 2010 to 2015.

Refer to pages 17 & 18 for supplemental information regarding pavement distress detailed during the July 2011 construction documentation regarding the eastbound 2010 project installation.

-Page 19 – March 2012 site inspection
-Page 22 – April 2013 site inspection
-Page 25 – April 2014 site inspection
-Page 29 – March 2015 final inspection

**Analysis to date:**

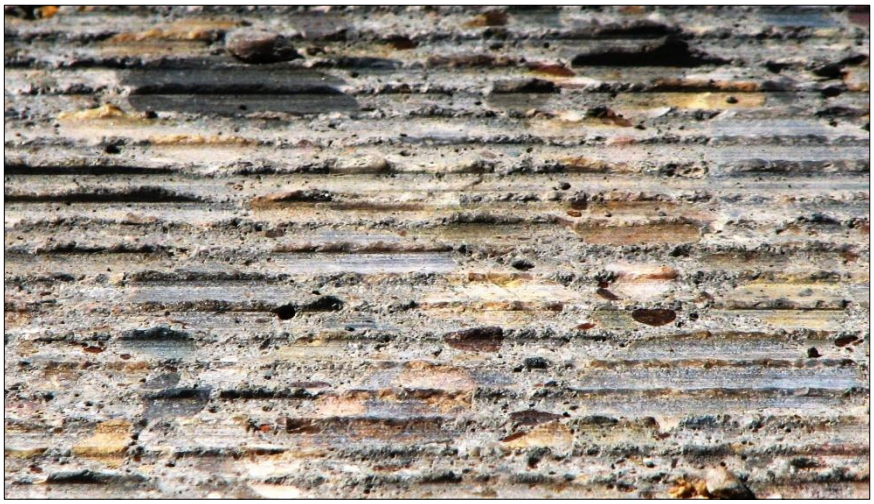
Based on visual inspection and documentation no abnormal surface deformations are detected on the overlay seal. Distress types (raveling, bleeding, rutting etc.) after 4-5 seasons (2010-EB/2011-WB) are at a minimum. Reflective joint cracking is rated at low-severity. To date this project has been rated as performing well.

**September 2010- East bound**

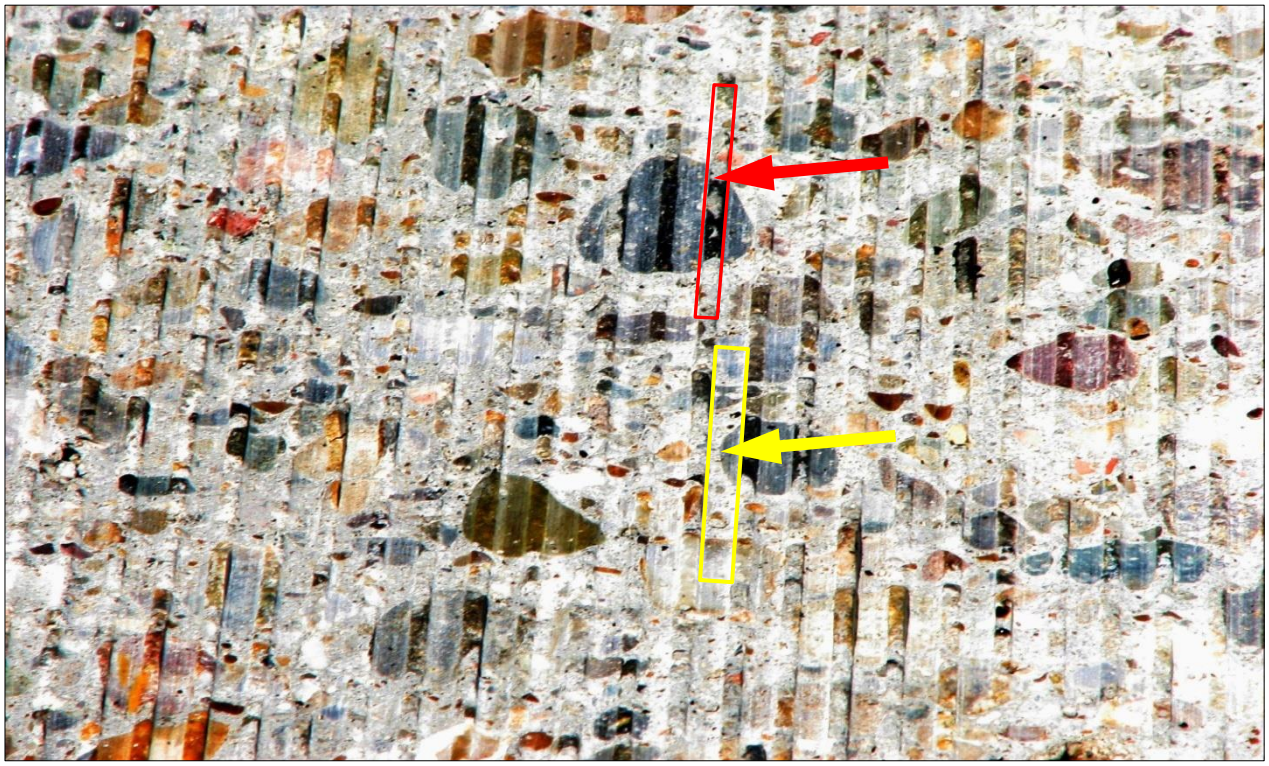
🡐 Condition of PCCP prior to diamond grind

🡐 Example image of the PCCP after grinding process.

This is termed a corduroy texture with an approximate grind depth of 0.84" (3.17 mm).



🡐 Lateral close-up of the diamond grind. Blade width is approximately .25" (6.3 mm).



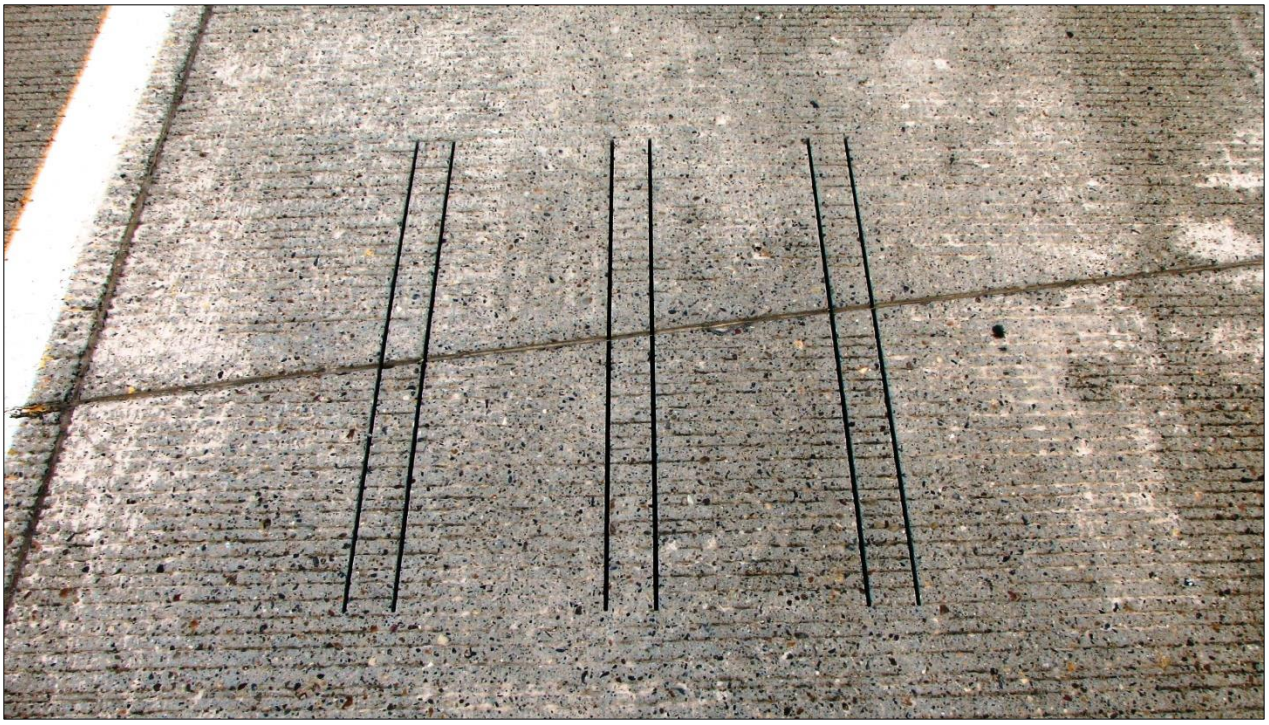
🡅 Above image gives a close-up, top view of the grind. The land area (the high relief-red arrow) as compared to the width (low relief) of the diamond blade (yellow arrow).

🡇 Image of the diamond grind apparatus; as the device progresses over the pavement, the ground particulates are vacuumed up and mixed with water to produce a slurry which through an extended pipe is deposited in the median (red arrow). The width of the grinding path is approximately 4.2' (1.3 m).

## Dowel Bar Retrofit

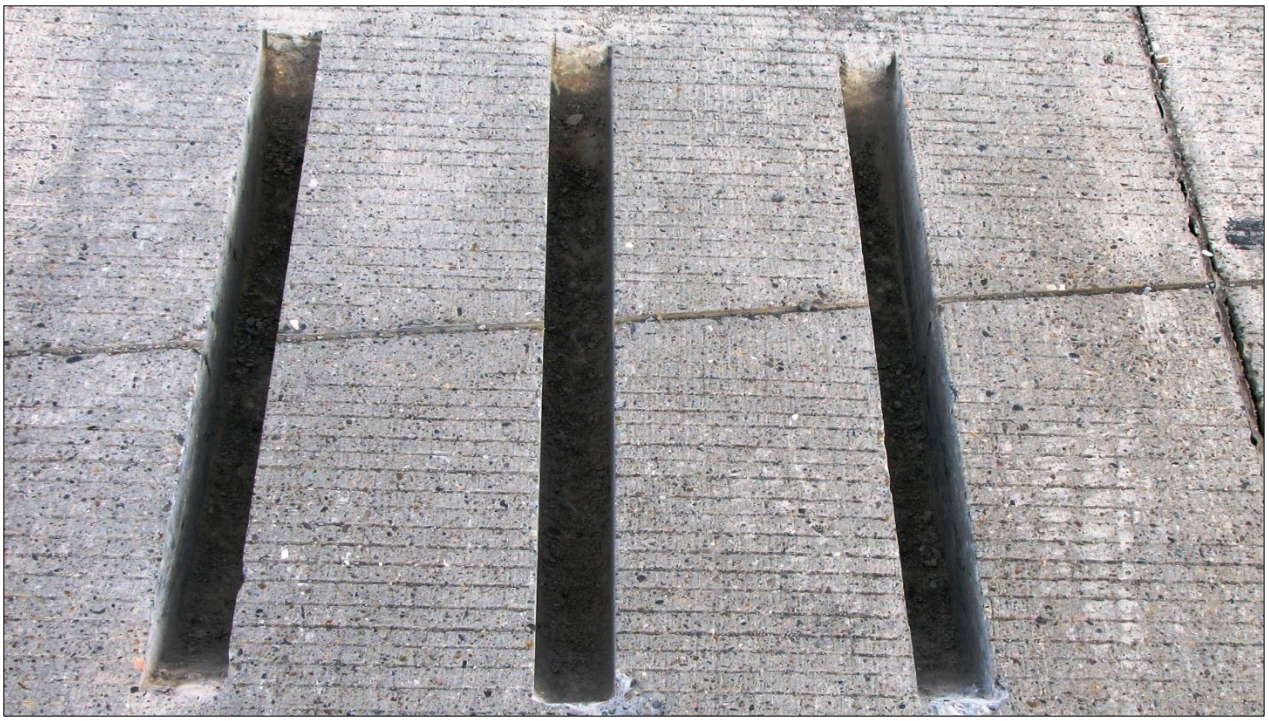
🡅 The apparatus that creates the grooves in preparation of the dowel bar slots.

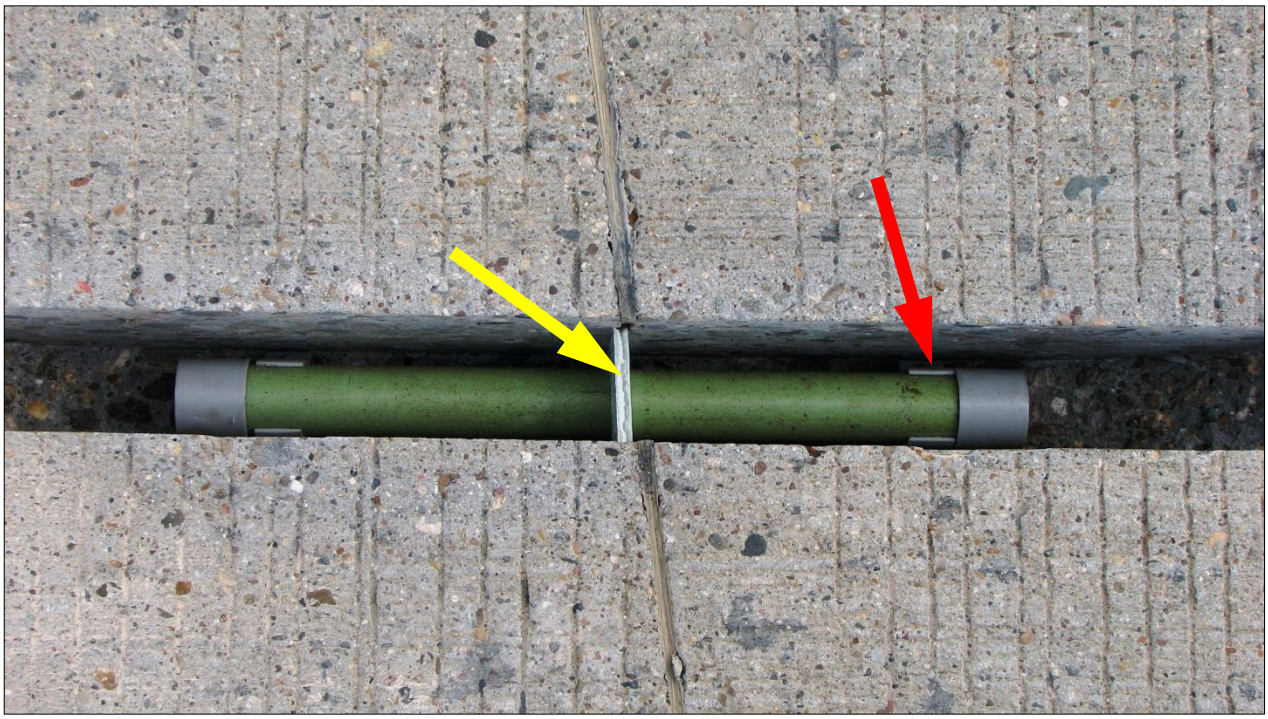
🡇 In this view the diamond saw slot cutter blades are placed in the appropriate spot and as slurry is produced it is vacuumed and deposited on the shoulder.



Saw cut slots were prepared such that dowel bars can be placed at the mid depth of the concrete slab, centered over the transverse joint, and parallel to the centerline and the roadway surface. Small handheld jackhammers are used to remove the fins.

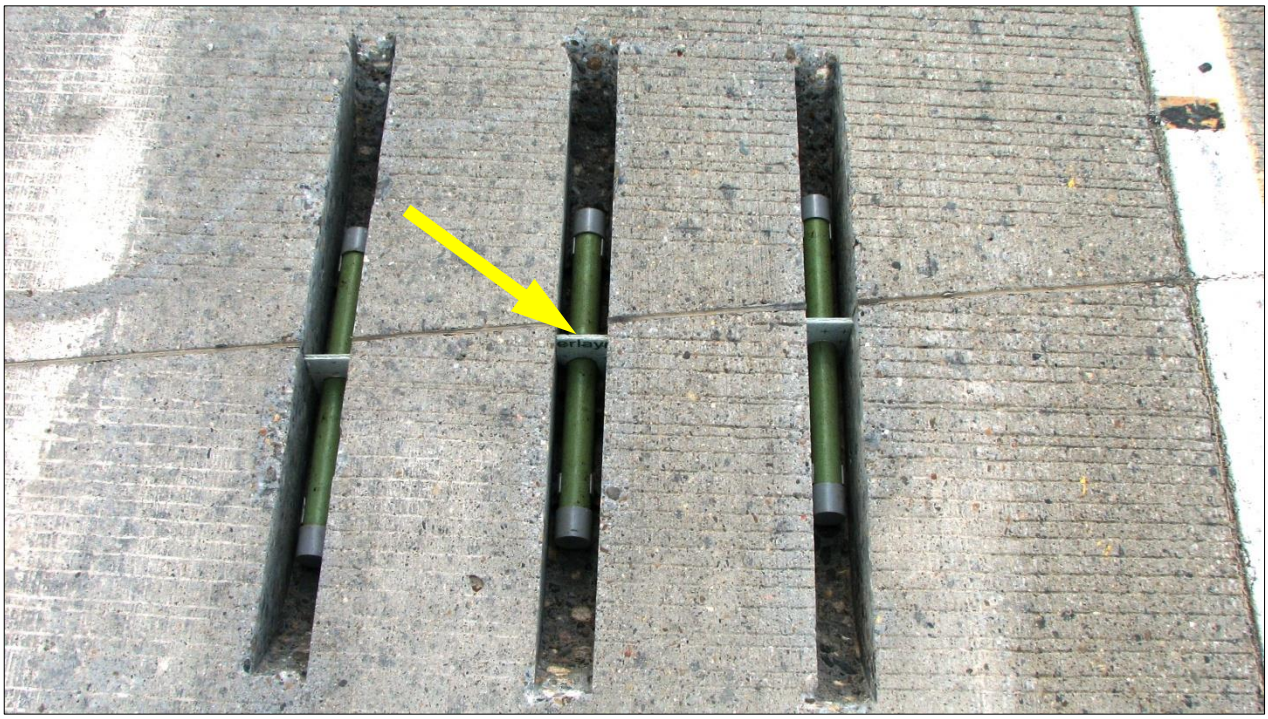
The alignments of saw cuts are parallel to the roadway centerline, regardless of transverse joint skew. All exposed surfaces and cracks in the slot must be cleaned to bare concrete to remove slurry, particulates, or other foreign materials prior to installation of the dowels.





The epoxy coated dowel bars must be positioned on a chair (red arrow) that will provide a minimum of 1/2 inch clearance between the bottom of the dowel and the bottom of the slot. The chairs should hold the dowel bar tightly in place during placement of the concrete patching material.

A 3/8 inch thick foam insert (yellow arrow) is placed at the middle of the dowel to maintain the transverse joint. The foam insert must fit tightly around the dowel, and the bottom and the edges of the slot.



🡐 Once the dowel bars are properly placed the grouting crew begins the patch application.

The grout is applied in a manner that does not cause the movement of the dowel bar within the slot.

🡐 With the grouting process completed the dowel slots are treated with a curing compound.

🡐 The transverse joint is maintained by saw cutting the surface with a hand pushed single blade saw. The cut width averages between 3/16 to 5/16 inch and the depth 1½ inch and must be sawed within 24 hours after placement of the concrete patching material.

After the joint sawing phase is completed, the pavement is swept free of debris in preparation of the diamond grind application.

## Plant Mix Seal Application

🡅 A tack coat is applied prior to the PMS paving phase.

🡇 The PMS paving in process.

🡅 Additional view of the paving process.

🡇 The PMS course compaction was done by a static steel wheel roller encompassing two complete coverage's. A complete coverage is defined as a roller pass forward and back within a given area.

🡸 Surface close-up of mat texture.

🡸 Thickness of the PMS was specified at 16 mm (.625").

Field measurements ran from 16 mm – 18 mm on average.

🡅 East bound lane with completed PMS course on 4ft. passing shoulder and both travel lanes (view east).

🡇 **July 2011** - East bound lane with completed PMS course on all lanes and shoulders (view west).

**July 2011 – West Bound Construction**

🡅 Completed and patched dowel retrofit with applied curing compound.

🡇 Micro-grinding in process, first pass of the travel lane.

🡅 Sample image of micro-grinding. As seen in the above image, based on a comparison of the condition of the eastbound grinding phase in 2011, the westbound displayed an inconsistent grind and coarser texture.

🡇 The image below is a close-up of the PCCP after grinding. Initially it was determined to use a skid loader blade to even the relief of the grind prior to applying the PMS. The paving proceeded without any corrective action to the current grind.

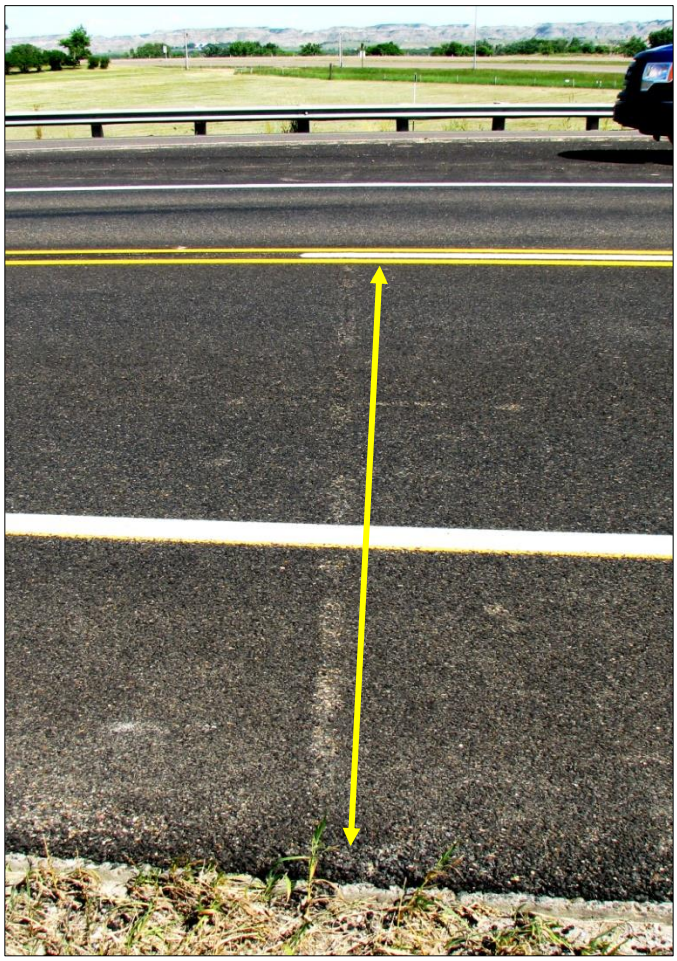
🡅 Sample image of the placement of the PMS course.

🡇 Paving of the westbound travel lane.

🡅 Close-up of the PMS course.

🡇 Completed paving of the travel, shoulder and passing westbound lanes at start of east end of project.

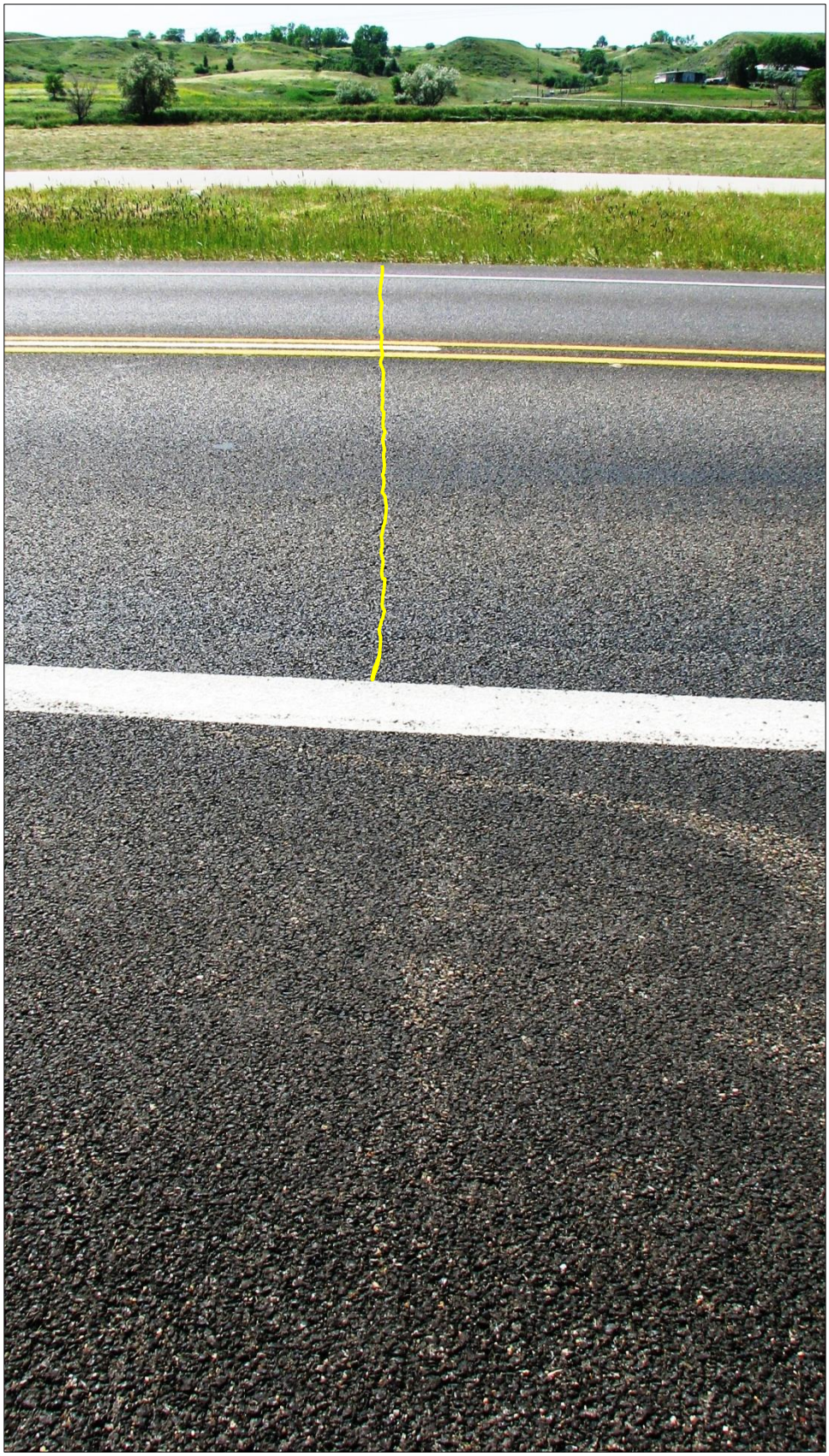
**Supplemental: Eastbound Passing Lane - West End of Project/July 2011**



🡸🡹 During the July 2011 site visit the MDT Project Manager directed Research to the west end of the eastbound lanes (constructed in 2010) to document apparent shadowing of the dowel slots (red circle) and the slab joints (denoted by yellow line). This condition was predominately in the passing lane and (at this time) encompassed about 2000ft. (610m) starting at the west end of the project.

On close inspection it was observed that the asphalt cement (AC) had been scraped from the aggregate apparently by plow passes. An assumption to this anomaly may be movement of the slab joint due to heavy loads in which the grouted slots are pushed up to a relief higher than the surrounding AC; though this movement is only 1-2 millimeters. Research will continue to monitor this condition in future evaluations.

**Supplemental: Joint Cracking- East Bound Lanes, West End of Project/July 2011**



🡐 The reflective joint crack in this image is difficult to see and is superimposed with a yellow line for better clarity. This crack is located at exit 210 just past the overpass. To date cracking is at a minimum and is rated as low-severity.

**March 2012 Site Inspection**

🡐 Eastbound PMS lanes at east end of project. View is looking west.

🡐 Westbound PMS lanes at east end of project. View is looking west.

🡅 Overview of project looking east at mile point 211.

🡄 Image of mat texture. Surface appearance is tight and uniform. No appreciable rutting was detected.

🡸 Joint reflection cracking (the PCCP underlying joint) is seen through the PMS layer. This cracking is on all underlying PCCP dowel-retrofit joints on the east bound portion of the project.

The image on the left shows a sample of that cracking.

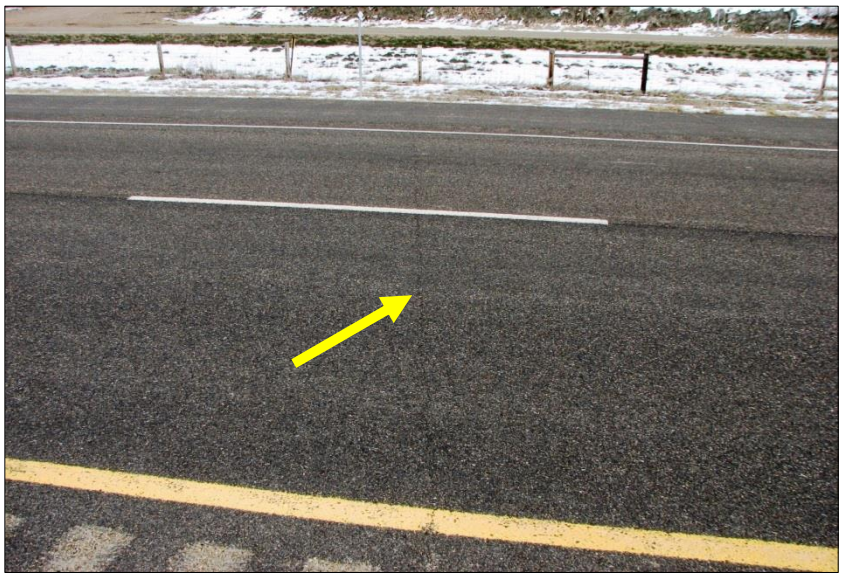
To date the west bound lanes also exhibits reflective cracking but the frequency is very minor.

🡻 The image below is a representative close-up of the reflective cracking. The crack is rated as low-severity (mean width of ≤6mm/0.25").

**April 2013 Site Inspection**

🡅 Image of eastbound lanes at east end of project; approximate mile point 218; view west.

🡇 Image of westbound lanes at east end of project; approximate mile point 218; view west.



🡐 Joint reflection cracking (the PCCP underlying joint) is seen through the PMS layer. This cracking is on all underlying PCCP dowel-retrofit joints on the west bound portion of the project as also seen on the eastbound lanes.

The image on the left shows a sample of that cracking.

🡐 A representative close-up of the reflective cracking in the westbound lanes. The crack is rated as low-severity (mean width of ≤6mm/0.25").

🡐 Close up of PMS top aggregate condition.

🡅 Reference point 211: Overview of project looking east. To date visual documentation portrays the PMS application and PCCP dowel retro-fit treatments as performing well.

**April 2014 Site Inspection**

🡅 Image of eastbound lanes at east end of project; approximate mile point 217; view west.

🡇 Image of westbound lanes at east end of project; approximate mile point 217; view east.

🡅 🡇 Representative Images of PMS surface texture. No abnormal surface deformation noticed. No apparent bleeding or raveling is perceptible throughout the project. Polishing of aggregate minimum.

🡐 Overlay surface joint reflection cracking on the project (which includes all PCCP underlying joints), is at low-severity.

The image on right depicts a crack typical on the project; on the low-end of severity cracking.

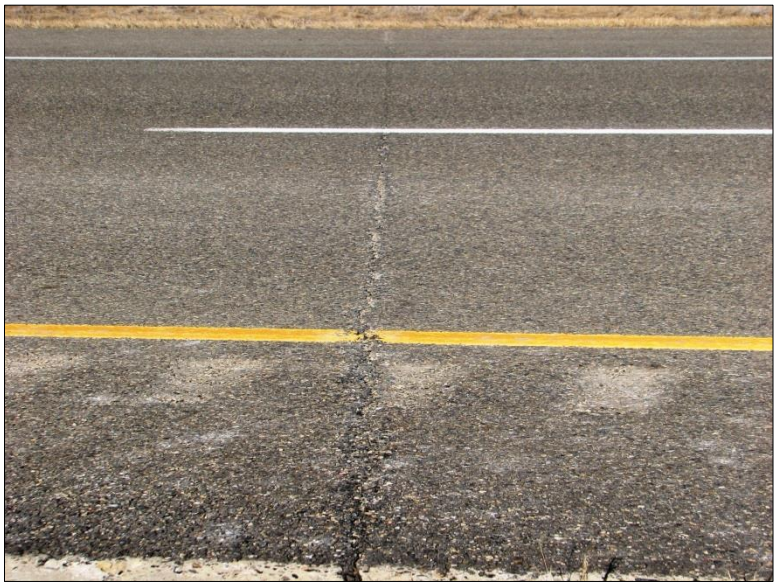
Reflective cracking at the pavement joints is considered normal for this type of project.

🡐 Minor longitudinal reflective cracking is noticed during this inspection. Not predominant to the entire project.

🡅 Reference point 211: Overview of project looking east. As of April 2014 visual documentation portrays the combined PMS application and PCCP dowel retro-fit treatments as performing well.

**March 2015 Site Inspections**

East end of project looking west; westbound lanes. Visual inspection of the overall project supports the combined PMS application and PCCP dowel retro-fit treatments as performing well. Pavement mat is tight with minor evidence of raveling or bleeding. Rutting is also at a minimum. On average reflective joint cracking is rated at low-severity.



🡸🡻 Representative images of pavement condition to reflective joint cracking and mat condition.