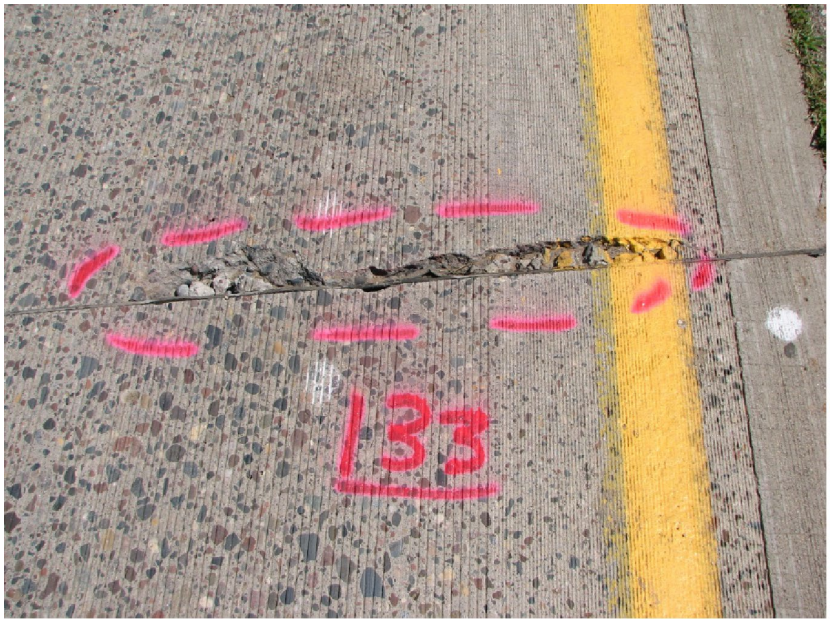
Minor Road Damage Repair



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EXECUTIVE SUMMARY

Jointed concrete pavements are designed and constructed to provide long periods of service to the traveling public. In the harsh climate of Minnesota, older generation concrete mix designs, like those specified by MnDOT in the early 1990s, have demonstrated a trend where significant joint distress begins to appear on the surface of the pavement at approximately 17 to 20 years of age. The original concrete pavement test sections at the MnROAD facility, constructed in 1993, utilized older generation concrete mix designs. Following the general trend, by 2011 several of the original concrete pavement test sections that remained in service began to exhibit materials related distress along the joints. To keep the test sections in service and safe for the traveling public, partial-depth joint repairs were performed.

The materials used in partial-depth concrete repairs are constantly being tested and improved, such that the repairs last longer and can be placed and opened to traffic more quickly. The need for partial-depth concrete repairs at MnROAD provided a good opportunity to evaluate both existing and new types of patching materials. This report describes the 3-year performance of 93 patches with 22 different materials.

Subjective condition ratings, based primarily on visual observations, were made over the 3-year evaluation period. A sounding, using a ball-peen hammer, provided bond condition information for each patch in October 2014. Results were tabulated first by MnROAD test cell number and patch material designation. Since patch performance can be affected by direct tire loading, tables organized by patch location and material type were presented next. A photographic record with condition rating for each patch was assembled and included in Appendix A.

Overall, 55 of the 93 (59%) patches remained in good serviceable condition as of October 2014.

The location of the patch did not seem to affect the performance significantly, with 61% and 67% of the patches in good condition near the centerline and loaded areas, respectively.

Since the objective of this study was not to directly compare the performance of the various materials, results were not presented in ranked order. Certain materials were installed by the supplier, who did not follow the standard installation procedure followed by MnROAD and MnDOT installers. This may have had negative effects on the condition rating, particularly when isolation/expansion joints were not reestablished.

As some of the materials used in this study were slower in gaining strength, they may not be of practical use in modern rehabilitation projects where early opening to traffic is important. Interestingly, many of the slower setting and strength gaining products performed very well.

CHAPTER 1: INTRODUCTION

1.1 Description of Study

Jointed concrete pavements are designed and constructed to provide long periods of service to the traveling public. In the harsh climate of Minnesota, older generation concrete mix designs, like those specified by MnDOT in the early 1990's, have demonstrated a trend where significant joint distress begins to appear on the surface of the pavement at approximately 17 to 20 years of age. The original concrete pavement test sections at the MnROAD facility, constructed in 1993, utilized older generation concrete mix designs. Following the general trend, by 2011 several of the original concrete pavement test sections that remained in service began to exhibit materials related distress along the joints. In order to keep the test sections in service and safe for the traveling public, partial-depth joint repairs were performed.

One of the objectives of the MnROAD facility is to showcase and evaluate new pavement designs and materials that extend pavement life. It was recognized that the repairs needed for the distressed concrete pavement test sections at MnROAD provided an opportunity to evaluate various repair materials, benefiting both research partners and the manufacturers of repair materials. This report highlights the 3-year performance of 93 partial-depth concrete joint repairs filled with 22 different materials.

1.2 Joint Distress in Concrete Pavements

As described previously, the extreme climate in Minnesota significantly stresses common pavement materials such as concrete and asphalt. Each joint in a jointed concrete pavement system creates an opportunity for water and deicing chemicals to enter the pavement system. When adequate drainage is present, this water leaves the system at a quick enough rate to avoid conditions conducive to such material damage as scouring or freeze/thaw deterioration. In reality, many joints fill up with debris, or joint seals become partially breached, therefore allowing the concrete near the joints to become critically saturated. Recent studies and guidelines on concrete pavement joint deterioration [1,2] have reported that once concrete becomes saturated beyond a critical level (~85%), damage can occur within 1 to 2 freeze/thaw events. To avoid such damage, either the concrete has to be strong and durable enough to counteract the freeze/thaw expansion forces, or improved drainage conditions and/or evaporation must exist to remove the moisture within the joint. Of course the presence of deicing chemicals can have a profound effect on the moisture condition of the concrete as well.

Older generation MnDOT concrete pavements (circa 1990) placed on slow draining base layers commonly develop joint distress both near the top and bottom regions of the joints. Near the surface of the pavement, cracking and material loss becomes visible in the vicinity of the joints (both transverse and longitudinal). Cracking, scouring, and material loss can occur both at mid-depth and near the bottom of joints, particularly with slow draining base layers under the pavement[3]. Examples of these types of distress at the MnROAD facility are shown in Figures 1.1 through 1.3.

The types of repairs highlighted in this report were those designed to address the surface distresses along joints. These types of distresses can be repaired successfully using what are

called “partial-depth” repairs. The details of this type of repair, and the materials used in the repairs at MnROAD, are more fully described in the following sections of this report.

Figure 1.1 Distress near the surface of a concrete pavement at intersection of transverse and centerline joints.

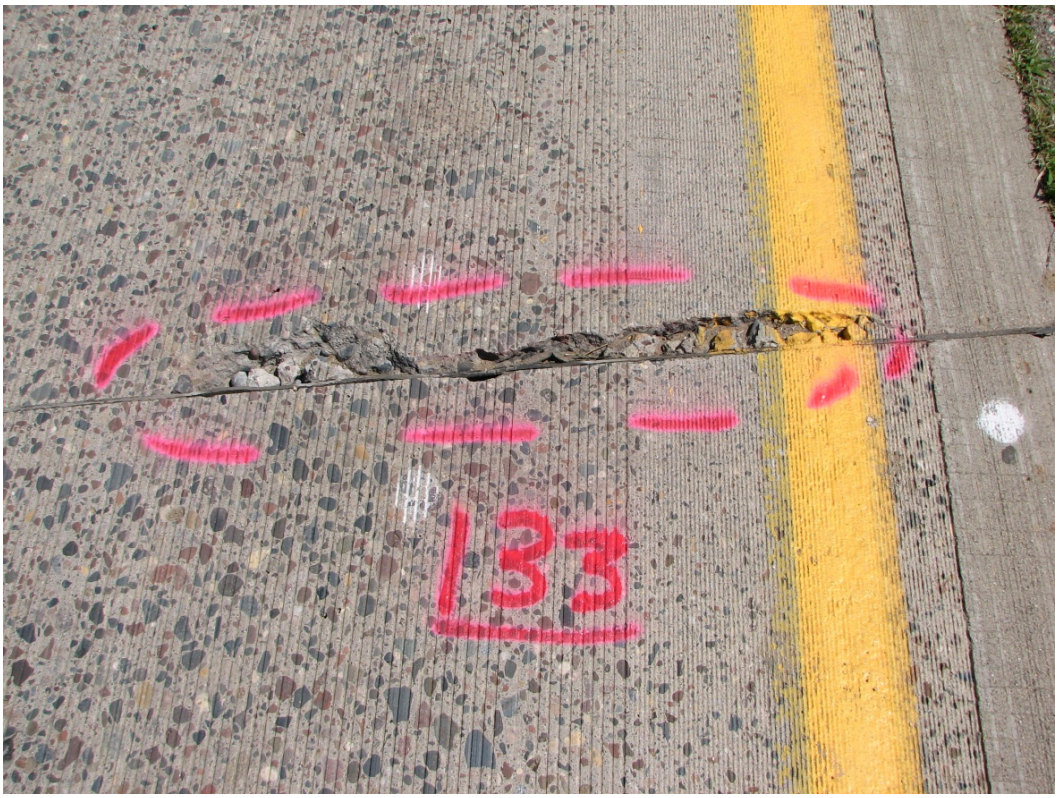

Figure 1.2. Distress near the surface of a concrete pavement along a transverse joint.

Figure 1.3. Distress at mid-depth and bottom of transverse joint placed on slow draining base layer [3].

1.3 Partial-Depth Joint Repairs in Concrete Pavement Joints

Partial depth repairs have become an effective way to extend the service life of concrete pavements in Minnesota. The process involves removing enough concrete material in the area of distress, such that sound concrete is available for the patching material to structurally bond to.

Further information, detailed drawings, and instructional videos can be found on the MnDOT website:

http://www.dot.state.mn.us/materials/concretepavementrehabilitation.html

Once the distressed material is removed (typically via milling), the repair area is sandblasted and cleaned in preparation for refilling with a patch material. The procedure used to complete most of the partial-depth joint repairs at MnROAD is listed below:

1. Preparation – mill area (rotary-head mill works well).
2. Jackhammer sides of repair area to match mill diameter.
3. Sandblast area to expose aggregate.
4. Vacuum, broom, and used compressed air to clean area.
5. To maintain working joint or cracks, cut joint expansion material to length for individual patches – fiberboard strips 0.75 in. wide by 1.5 in. deep were used at MnROAD.
6. Drill and install rebar in corners of repair (where needed, see MnDOT boiler plate for type BE repair).
7. For cementitious based repair materials, "prime" the milled areas with slurry: 2 parts cement and 1 part sand, with enough water to create a paste. This was not done for asphalt-based repairs.
8. Install patch material.
9. Finish patch to match surrounding texture (if possible) – apply a broom finish.
10. Cure repair materials using a plastic cover (except asphalt-based repair products).

Note that installations at MnROAD were done by either MnROAD/MnDOT staff or product suppliers. Since some of the repair materials were asphalt-based, or were installed by the supplier, some of the steps listed above were modified. In particular, several suppliers chose to install their product without reestablishing the working joints. They also may have chosen to forego the prime coat of cement, sand and water in certain locations.

Typical completed partial-depth repairs are shown in Figures 1.4 and 1.5.

Figure 1.4. Typical MnROAD partial-depth repair with cementitious-based material.

Figure 1.5. Typical MnROAD partial-depth repair with asphalt-based material.

1.4 Repair Materials

This report summarizes the 3-year performance of 93 concrete joints repaired with 22 different materials. These repairs are located in MnROAD test Cells 7-9 and 12. While other test cells at MnROAD received similar repairs in 2011, several of those cells were subsequently removed from service over the 3 year analysis period, and thus were not included in this report.

The type of materials used in the repairs varied from cementitious-based, to epoxy-based, to asphalt-based. The focus of this report is on the performance of the individual patches, and therefore specific details of individual materials will not be listed or discussed. Table 1.1 lists the repair material name, general material type, and the manufacturer or supplier. Additional information for a particular mix can be found by contacting the manufacturer or supplier.

Table 1.1. Repair materials installed at MnROAD in 2011.

Product Trade Name	Material type	Manufacturer/Supplier
Akona Rapid Patch Pavement Repair - includes NRRI Taconite products	Epoxy	TCC Materials/NRRI
Akona Rapid Patch Concrete Surface Repair	Cementitious	TCC Materials
BASF 10-61 Surface Repair (now called: MasterEmaco T 1061)	Cementitious	BASF Corporation
Concrete Patching Mix – Grade 3U18 w/air, HRWA and Fast Set admixtures	Cementitious	TCC Materials
DOTLINE Rapid Repair	Cementitious	CeraTech, Inc.
EMACO S88 CI	Cementitious	BASF Corporation
Hot Mix Asphalt 2341-A	Asphalt	Ohman Brothers
MAIN LINE Rapid Repair Concrete	Cementitious	CeraTech, Inc.
MAPEI Planitop XS	Cementitious	MAPEI
Patch Set 928	Cementitious	Dayton Superior/Unitex
Pavemend SL	Cementitious	CeraTech, Inc.
Perma-Patch	Asphalt	Perma-Patch, Inc.
Pro-Poxy 2500	Epoxy	Dayton Superior/Unitex

Pro-Poxy AWP	Epoxy	Dayton Superior/Unitex
Rapid Set – DOT Repair Mix	Cementitious	CTS Cement
Rapid Set - DOT PCC	Cementitious	CTS Cement
Rapid Set – Concrete Mix/DOT Repair Mix	Cementitious	CTS Cement
Ready Mix #2 - 303A32F	Cementitious	Knife River
Ready Mix #3 - 303A32F	Cementitious	Knife River
Sikacrete + Cement/Sand (Blend)	Cementitious	Sika Corporation
Spray Patch	Asphalt	RCM Specialties
TCC Concrete Patching Mix-Grade 3U18	Cementitious	TCC Materials

CHAPTER 2: PERFORMANCE

2.1 Patch Performance

The condition of the patches and repair materials in this study was documented periodically with photographs taken over the three year evaluation period. Figure 2.1 shows an example from the photo logs that were developed to help with the assessment of performance over time. A full set of photo logs of the patches in MnROAD Cells 7-9 and 12 can be found in Appendix A.

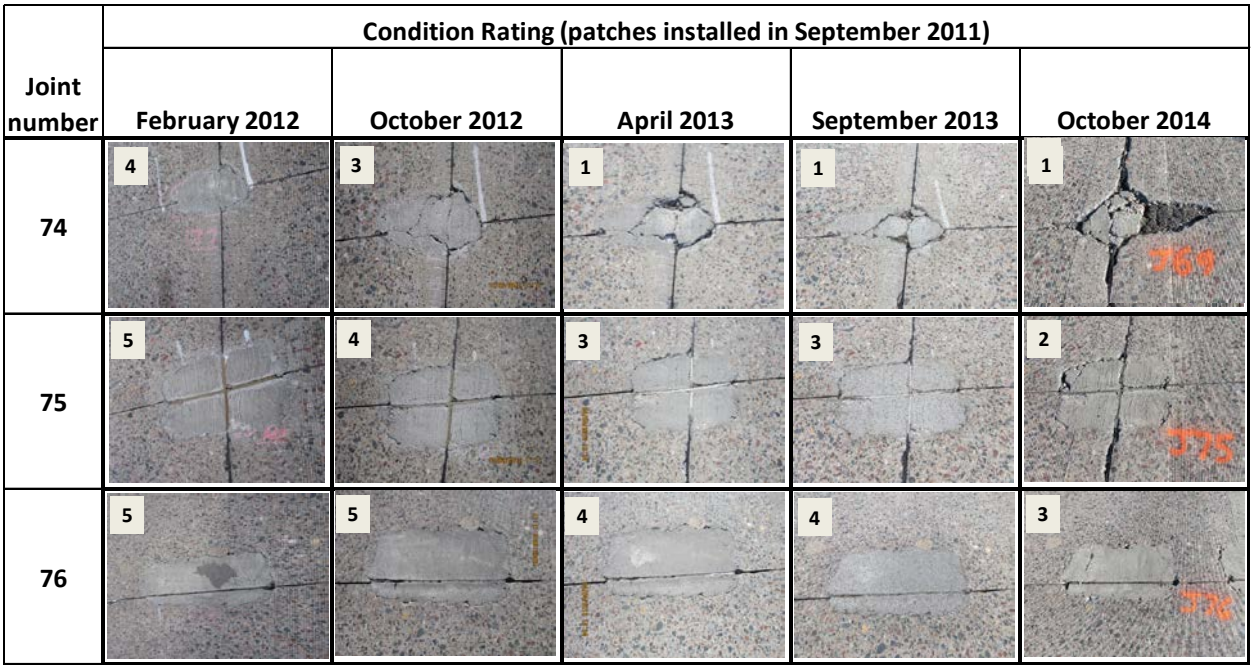

Figure 2.1. Example from Appendix A photo log of performance for repairs in MnROAD Cell 7.

As shown in Figure 2.1, the photo logs in Appendix A also contain the subjective rating of each patch over time. The ratings are based on visual assessments of the patch, as well as periodic determination of the soundness of the bond between the patch material and the pavement. During the October 2014 field assessment, a ball-peen hammer was used to test for the consistency of the tone within each patch area, with "hollow" sounds indicating compromised bonding of the patch material. Table 2.1 describes the subjective patch condition rating system used in this study. Tables 2.2 through 2.5 show the condition rating for the patches in each cell over the evaluation period.

Table 2.1. Condition rating system for MnROAD patches.

Rating	Condition of patch material (visual observation)
5	Excellent condition, no random cracking
4	Very good condition, small number of tight random cracks
3	Good condition, some random cracks, limited material missing
2	Fair condition, multiple wide random cracks, some material missing
1	Poor condition, substantial material missing, some areas refilled
0	Failed patch, patch completed refilled

Table 2.2. Condition ratings (sorted by material type) for patches in MnROAD Cell 7.

Patch Material	Joint Number	Patch location	Condition rating					Bonding condition Oct 2014
			Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
Blow Patch - RCM	91	Centerline	5	5	4	---	4	Full
Blow Patch - RCM	91	Pass Ln	5	5	4	---	4	Full
Blow Patch - RCM	92	Centerline	5	5	4	---	3	Partial - some areas
Blow Patch - RCM	92	Drive Ln	5	4	3	---	3	Full
Ready Mix 3 - 303A32F	69	Centerline	---	---	---	---	1	Full
Ready Mix 3 - 303A32F	74	Centerline	4	3	1	1	1	Full
Ready Mix 3 - 303A32F	75	Centerline	5	4	3	3	2	Partial - NE corner
Ready Mix 3 - 303A32F	76	Drive Ln	5	5	4	4	3	Full
Ready Mix 3 - 303A32F	76	Centerline	5	5	5	5	4	Full
Ready Mix 3 - 303A32F	77	Pass Ln	5	5	5	5	5	Full

Ready Mix 3 - 303A32F	80	Drive Ln	4	2	2	---	1	Partial - West half
Ready Mix 3 - 303A32F	82	Pass Ln	---	---	---	---	5	Full
Ready Mix 3 - 303A32F	84	Pass Ln	5	5	4	---	4	Partial - SE corner
Ready Mix 3 - 303A32F	84	Drive Ln	5	4	4	---	4	Full
Ready Mix 3 - 303A32F	85	Drive Ln	5	5	5	---	4	Full
Ready Mix 3 - 303A32F	85	Drive Ln	5	4	4	---	4	Full
Ready Mix 3 - 303A32F	87	Drive Ln	5	5	4	---	4	Full
Ready Mix 3 - 303A32F	88	Drive Ln	5	4	4	---	2	Full except by core hole
Ready Mix 3 - 303A32F	89	Pass Ln	5	5	5	---	4	Full

Table 2.3. Condition ratings (sorted by material type) for patches in MnROAD Cell 8.

Patch Material	Joint Number	Patch location	Condition rating					Bonding condition Oct 2014
			Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
BASF 10-61 Surface Repair	112	Centerline	4	4	3	---	2	Full
Blow Patch - RCM	94	Centerline	5	5	4	---	4	Full
Blow Patch - RCM	95	Drive Ln	4	4	3	---	0	Full
Blow Patch - RCM	95	Drive Ln	5	4	4	---	3	Full
Blow Patch - RCM	95	Pass Ln	5	5	3	---	3	Full
DOTLINE Rapid Repair	119	Drive Ln	5	5	5	---	2	Full
EMACO S88 C1	114	Centerline	5	4	4	---	3	Full
Mainline 4 hour PCC	109	Pass Ln	2	2	1	---	1	None
MAPEI Plaintop XS	111	Pass Ln	4	3	3	---	2	Full
Rapid Set - Green/Orange	127	Centerline/ Pass Ln	4	4	3	---	3	Full
Rapid Set - Green/Orange	128	Centerline/ Drive Ln	3	2	2	---	1	Full
Rapid Set - Green/Orange	129	Centerline	3	3	3	---	2	Full
Rapid Set - Green/Orange	129	Pass Lane	4	4	4	---	4	Full
Rapid Set - Orange	125	Centerline	4	4	2	---	1	Full

Rapid Set - Orange	126	Centerline	4	4	3	---	3	Full
Ready Mix 2 - 303A32F	101	Centerline	4	4	4	---	2	Partial - NW corner
Ready Mix 2 - 303A32F	101	Pass Lane	5	5	4	---	2	Partial - West side
Ready Mix 2 - 303A32F	102	Drive Ln	5	4	3	---	1	Full - with patch
Ready Mix 2 - 303A32F	104	Drive Ln	5	4	3	---	2	Partial along W side of transv jt
Ready Mix 2 - 303A32F	104	Centerline	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	107	Drive Ln	5	4	3	---	1	Partial - West side
Ready Mix 2 - 303A32F	108	Centerline	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	110	Pass Ln	5	5	5	---	5	Full
Ready Mix 2 - 303A32F	113	Centerline	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	115	Centerline	5	5	5	---	3	Partial - SW & NE corners
Ready Mix 2 - 303A32F	116	Centerline	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	118	Centerline	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	118	Drive Ln	5	5	5	---	5	Full
Ready Mix 2 - 303A32F	119	Drive Ln	5	5	5	---	4	Partial - NW edge
Ready Mix 2 - 303A32F	119	Centerline	4	3	2	---	0	Full

Ready Mix 2 - 303A32F	121	Centerline/ Pass Ln	5	4	4	---	4	Full
Ready Mix 2 - 303A32F	122	Centerline	4	2	1	---	0	Partial - Large area to South
Ready Mix 2 - 303A32F	123	Centerline	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	123	Drive Ln	5	5	5	---	5	Full
Ready Mix 2 - 303A32F	124	Drive Ln	4	4	4	---	3	Partial - South end
Sikacrete + Cement/Sand (Blend)	117	Centerline	4	4	4	---	3	Full

Table 2.4. Condition ratings (sorted by material type) for patches in MnROAD Cell 9.

Patch Material	Joint Number	Patch location	Condition rating					Bonding condition Oct 2014
			Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
Akona Rapid Patch Concrete Surface Repair - extended w/ pea gravel	159	Centerline	5	4	4	3	2	Partial - West half
Akona Rapid Patch Pavement Repair (NRRI)	154	Pass Ln	5	4	2	1	0	Full
Akona Rapid Patch Pavement Repair (NRRI)	155	Centerline	5	4	3	3	1	Partial - some areas
Akona Rapid Patch Pavement Repair (NRRI)	156	Centerline/ Drive/Pass Ln	5	3	2	1	0	Partial - along centerline
Akona Rapid Patch Pavement Repair (NRRI) -extended w/ coarse sand	161	Centerline	5	5	2	1	0	Partial - near joint intersection
Akona Rapid Patch Pavement Repair (NRRI) -extended w/ coarse sand	162	Centerline/ Pass Ln	5	3	1	1	0	Partial - many areas
Hot Mix - 2341-A	163	Centerline/ Drive/Pass Ln	5	5	5	5	5	Full
Hot Mix - 2341-A	164	Centerline	5	5	5	5	5	Full
Patch Set 928	140	Centerline	---	3	3	3	3	Full
Pavemend SL	131	Centerline	---	5	5	5	5	Full
Propoxy 2500	141	Centerline	---	5	5	5	5	Full

Propoxy 2500	144	Centerline	---	5	5	5	4	Full
Propoxy 2500	145	Centerline/ Drive/Pass Ln	5	5	5	5	4	Partial - near joint intersection
Propoxy 2500	146	Driving Lane	---	5	5	5	5	Full
Propoxy AWP	141	Passing Lane	---	4	4	4	3	Partial - OWP
Rapid Set DOT	132	Centerline	---	4	4	4	4	Full
Rapid Set DOT	133	Passing Lane	---	4	4	4	4	Full
Rapid Set DOT	134	Centerline	---	4	4	4	4	Full
Rapid Set DOT	135	Centerline	---	4	4	3	3	Full
Rapid Set DOT	136	Centerline	---	4	3	2	2	Full
Rapid Set DOT 4 PCC	139	Centerline	---	4	4	4	4	Full
Rapid Set PCC	137	Centerline	---	4	3	3	3	Full
Rapid Set PCC	138	Centerline	---	4	4	4	4	Full
Rapid Set PCC	138	Driving Lane	---	4	3	3	3	Full
Ready Mix 3 - 303A32F	146	Centerline	---	5	5	5	5	Full
Ready Mix 3 - 303A32F	147	Centerline	---	5	5	5	5	Full
Ready Mix 3 - 303A32F	148	Centerline	---	5	4	4	3	Partial - East half

Ready Mix 3 - 303A32F	150	Centerline	---	5	5	5	5	Full
Ready Mix 3 - 303A32F	153	Centerline/ Drive/Pass Ln	5	5	5	5	4	Partial - SE corner
TCC Concrete Patching Mix-Grade 3U18 - w/ dry HRWA and air entraining	151	Centerline	5	5	4	4	4	Full

Table 2.5. Condition ratings (sorted by material type) for patches in MnROAD Cell 12.

Patch Material	Joint Number	Patch location	Condition Rating					Bonding condition Oct 2014
			Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
Permapatch	216	Centerline	3	3	3	---	2	Partial areas
Permapatch	221	Centerline	5	5	3	---	2	Full
Permapatch	222	Centerline	4	4	3	---	2	Partial areas
Permapatch	223	Centerline	5	5	3	---	2	Partial areas
Permapatch	224	Centerline	4	4	3	---	2	Partial areas
Permapatch	236	Centerline	4	3	3	---	2	Partial areas

In addition to freeze/thaw durability and the retention of bond to the underlying pavement, some patch materials must also survive direct vehicular loading. As one would expect, patches lying in wheel paths are subject more often to direct tire loads, as well as the opening and closing of the transverse joints. Tables 2.6 through 2.8 are designed to demonstrate the effect of the location of the patch on performance.

Table 2.6. Condition ratings for patches near or spanning the centerline (by material type).

Patch Material Type	Joint Number	Condition Rating					Bonding condition Oct 2014
		Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
Akona Rapid Patch Concrete Surface Repair	159	5	4	4	3	2	Partial
Akona Rapid Patch Pavement Repair (NRRI)	155	5	4	3	3	1	Partial
Akona Rapid Patch Pavement Repair (NRRI)	161	5	5	2	1	0	Partial
BASF 10-61 Surface Repair	112	4	4	3	---	2	Full
Blow Patch - RCM	91	5	5	4	---	4	Full
Blow Patch - RCM	92	5	5	4	---	3	Partial
Blow Patch - RCM	94	5	5	4	---	4	Full
EMACO S88 C1	114	5	4	4	---	3	Full
Hot Mix - 2341-A	164	5	5	5	5	5	Full
Patch Set 928	140	---	3	3	3	3	Full
Pavemend SL	131	---	5	5	5	5	Full
Permapatch	216	3	3	3	---	2	Partial
Permapatch	221	5	5	3	---	2	Full
Permapatch	222	4	4	3	---	2	Partial

Permapatch	223	5	5	3	---	2	Partial
Permapatch	224	4	4	3	---	2	Partial
Permapatch	236	4	3	3	---	2	Partial
Propoxy 2500	141	---	5	5	5	5	Full
Propoxy 2500	144	---	5	5	5	4	Full
Rapid Set - Green/Orange	129	3	3	3	---	2	Full
Rapid Set - Orange	125	4	4	2	---	1	Full
Rapid Set - Orange	126	4	4	3	---	3	Full
Rapid Set DOT	132	---	4	4	4	4	Full
Rapid Set DOT	134	---	4	4	4	4	Full
Rapid Set DOT	135	---	4	4	3	3	Full
Rapid Set DOT	136	---	4	3	2	2	Full
Rapid Set DOT 4 PCC	139	---	4	4	4	4	Full
Rapid Set PCC	137	---	4	3	3	3	Full
Rapid Set PCC	138	---	4	4	4	4	Full
Ready Mix 2 - 303A32F	101	4	4	4	---	2	Partial
Ready Mix 2 - 303A32F	104	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	108	5	5	5	---	4	Full

Ready Mix 2 - 303A32F	113	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	115	5	5	5	---	3	Partial
Ready Mix 2 - 303A32F	116	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	118	5	5	5	---	4	Full
Ready Mix 2 - 303A32F	119	4	3	2	---	0	Full
Ready Mix 2 - 303A32F	122	4	2	1	---	0	Partial
Ready Mix 2 - 303A32F	123	5	5	5	---	4	Full
Ready Mix 3 - 303A32F	69	---	---	---	---	1	Full
Ready Mix 3 - 303A32F	74	4	3	1	1	1	Full
Ready Mix 3 - 303A32F	75	5	4	3	3	2	Partial
Ready Mix 3 - 303A32F	76	5	5	5	5	4	Full
Ready Mix 3 - 303A32F	146	---	5	5	5	5	Full
Ready Mix 3 - 303A32F	147	---	5	5	5	5	Full
Ready Mix 3 - 303A32F	148	---	5	4	4	3	Partial
Ready Mix 3 - 303A32F	150	---	5	5	5	5	Full
Sikacrete + Cement/Sand (Blend)	117	4	4	4	---	3	Full
TCC Concrete Patching Mix-Grade 3U18 - w/ dry HRWA and air entraining	151	5	5	4	4	4	Full

Table 2.7. Condition ratings for patches within driving or passing lanes and spanning the centerline (by material type).

Patch Material Type	Joint Number	Condition Rating					Bonding condition Oct 2014
		Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
Akona Rapid Patch Pavement Repair (NRRI)	156	5	3	2	1	0	Partial
Akona Rapid Patch Pavement Repair (NRRI) - extended w/ coarse sand	162	5	3	1	1	0	Partial
Hot Mix - 2341-A	163	5	5	5	5	5	Full
Propoxy 2500	145	5	5	5	5	4	Partial
Rapid Set - Green/Orange	127	4	4	3	---	3	Full
Rapid Set - Green/Orange	128	3	2	2	---	1	Full
Ready Mix 2 - 303A32F	121	5	4	4	---	4	Full
Ready Mix 3 - 303A32F	153	5	5	5	5	4	Partial

Table 2.8. Condition ratings for patches within driving or passing lane (by material type).

Patch Material Type	Joint Number	Condition Rating					Bonding condition Oct 2014
		Feb 2012	Oct 2012	Apr 2013	Sep 2013	Oct 2014	
Akona Rapid Patch Pavement Repair (NRRI)	154	5	4	2	1	0	Full
Blow Patch - RCM	91	5	5	4	---	4	Full
Blow Patch - RCM	92	5	4	3	---	3	Full
Blow Patch - RCM	95	5	4	4	---	3	Full
Blow Patch - RCM	95	4	4	3	---	0	Full
Blow Patch - RCM	95	5	5	3	---	3	Full
DOTLINE Rapid Repair	119	5	5	5	---	2	Full
Mainline 4 hour PCC	109	2	2	1	---	1	None
MAPEI Plaintop XS	111	4	3	3	---	2	Full
Propoxy 2500	146	---	5	5	5	5	Full
Propoxy AWP	141	---	4	4	4	3	Partial
Rapid Set - Green/Orange	129	4	4	4	---	4	Full
Rapid Set DOT	133	---	4	4	4	4	Full
Rapid Set PCC	138	---	4	3	3	3	Full

Ready Mix 2 - 303A32F	101	5	5	4	---	2	Partial
Ready Mix 2 - 303A32F	102	5	4	3	---	1	Full
Ready Mix 2 - 303A32F	104	5	4	3	---	2	Partial
Ready Mix 2 - 303A32F	107	5	4	3	---	1	Partial
Ready Mix 2 - 303A32F	110	5	5	5	---	5	Full
Ready Mix 2 - 303A32F	118	5	5	5	---	5	Full
Ready Mix 2 - 303A32F	119	5	5	5	---	4	Partial
Ready Mix 2 - 303A32F	123	5	5	5	---	5	Full
Ready Mix 2 - 303A32F	124	4	4	4	---	3	Partial
Ready Mix 3 - 303A32F	76	5	5	4	4	3	Full
Ready Mix 3 - 303A32F	77	5	5	5	5	5	Full
Ready Mix 3 - 303A32F	80	4	2	2	---	1	Partial
Ready Mix 3 - 303A32F	82	---	---	---	---	5	Full
Ready Mix 3 - 303A32F	84	5	4	4	---	4	Full
Ready Mix 3 - 303A32F	84	5	5	4	---	4	Partial
Ready Mix 3 - 303A32F	85	5	5	5	---	4	Full
Ready Mix 3 - 303A32F	85	5	4	4	---	4	Full
Ready Mix 3 - 303A32F	87	5	5	4	---	4	Full

Ready Mix 3 - 303A32F	88	5	4	4	---	2	Full
Ready Mix 3 - 303A32F	89	5	5	5	---	4	Full

CHAPTER 3: CONCLUSIONS

Partial depth repairs have become an effective way to extend the service life of concrete pavements in Minnesota. The materials used in those repairs are constantly being tested and improved, such that the repairs last longer and can be placed and opened to traffic more quickly. In 2011, surface deterioration along joints in several of the original concrete pavement test sections at MnROAD had reached a point that they needed to be repaired to keep the sections in service. This provided a good opportunity to evaluate the performance of partial-depth concrete repairs with 22 different patching materials. This report describes the performance of the patches after 3 years of Minnesota climate and interstate traffic.

In this report, the subjective condition of each patch was presented over the 3-year evaluation period. Condition rating was based primarily on visual observations. A sounding, using a ball-peen hammer, provided bond condition information for each patch in October 2014. Results were tabulated first by MnROAD test cell number and patch material designation. Since patch performance can be affected by direct tire loading, tables organized by patch location and material type were presented next. A photographic record with condition rating for each patch was assembled and included in Appendix A.

Overall, 55 of the 93 (59%) patches remained in good serviceable condition as of October 2014.

The location of the patch did not seem to affect the performance significantly, with 61% and 67% of the patches in good condition near the centerline and loaded areas, respectively.

Since the objective of this study was not to directly compare the performance of the various materials, results were not presented in ranked order. It is important to remember that certain materials were installed by a supplier, and some suppliers did not follow the standard installation procedure followed by MnROAD and MnDOT installers. This may have had negative effects on the condition rating, particularly when isolation/expansion joints were not reestablished.

As some of the materials used in this study were slower in gaining strength, they may not be of practical use in modern rehabilitation projects where early opening to traffic is important. Interestingly, many of the slower setting and strength gaining products performed very well.

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