Research Pays Off Series

Safer, Smarter, Sustainable Pavements through Innovative Research

MnROAD PCC Preservation - Research Update

July 19th, 2016

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National Road Research Alliance

We all have a stake in A to B

Agenda

- MnROAD PCC partial-depth repair performance
- Laboratory study for PCC patching materials
- Current research related to PCC repair techniques

MnROAD

Unique features:

- **Variety of designs and materials**
- **Ability to be bold**
- **Longevity**

NRRA
National Road Research Alliance

Joint Distress at MnROAD

- **Concrete cells 17 years old in 2010**
- **Typical surface deterioration along joints for early 1990's MnDOT mixes**
- **Opportunity for evaluation of various repair materials**

Partial-Depth Joint Repairs

Installed in 2011

- **93 concrete joints repaired**
- **22 different repair materials (includes asphalt)**
- **Many donated products (some installed by supplier)**
- **Distress and soundness surveys conducted 5 times over 3 years**

MnDOT Report 2016-16:
"Performance of Partial-Depth Concrete Pavement Repairs at the MnROAD Facility"
Authors: Tom Burnham, Eddie Johnson, Ben Worel

http://www.lrrb.org/media/reports/201616.pdf

Partial-Depth Joint Repairs

Preparation Procedure

- **Rotary-head mill & vacuum**
- **Jackhammer sides of repair area to match mill diameter**
- **Sandblast area to expose aggregate**
- **Vacuum, broom, and clean with compressed air**

Repair materials

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

Installation

- **Many donated materials installed by supplier**
  - **Retained control of installation**

- **All other installations done by MnROAD staff**
  - **Followed recommended MnDOT guidelines**

Installation Procedures

Repair Performance

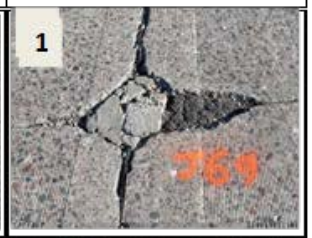
- Repairs were monitored (visual distress survey) and photographed 4 to 5 times during the evaluation period
- Final evaluation completed in October 2014
  - Included sounding with hammer to determine bond
- Created subjective condition rating system

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

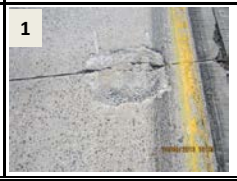
Repair Performance

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

Condition Histories

Joint number	Condition Rating (patches installed in September 2011)				
	February 2012	October 2012	April 2013	September 2013	October 2014
74					
75					
76					

Condition Histories

Joint number	Location	Patch material	Condition Rating (patches installed in September 2011)					Bonding condition Fall 2014
			February 2012	October 2012	April 2013	September 2013	October 2014	
107	Driving Lane	Ready Mix 2 - 303A32F	5	4	3		1	Partial - West side
108	Centerline	Ready Mix 2 - 303A32F	5	5	5		4	Full
109	Passing Lane	Mainline 4 hour PCC	2	2	1 		1	None

General Comments

- **Performance can depend on location of repair**
  - **Wheel path (frequently loaded)**
  - **Centerline (infrequent loading)**

- **Performance can depend on installation procedure**
  - **Reestablishment of working joints**
  - **Establishing good bond**

- **Ready-Mix repairs performed well**
  - **Slow to set**
  - **Difficult to place**
  - **Constructed to MnDOT guidelines**

http://www.lrrb.org/media/reports/201616.pdf

Laboratory Evaluation of Partial Depth Patching Materials for Use in Winter Climates

Jay Dailey and Robert Kostick
University of Minnesota Duluth

Eshan Dave
University of New Hampshire

Eric Musselman
Villanova University

Summary and Conclusions

- Laboratory testing based material acceptance process is recommended to be used as routine practice
  - ASTM C928 is very good starting point, some changes are strongly recommended through the present study
- Modulus of Elasticity
  - No specific target value, but should require it to be close to rest of the pavement
- Freeze-thaw testing
  - Current requirements primarily focus on durability factor (DF)
  - Both RDM and mass loss should be included in the requirements
- Bonding of patching materials
  - Chemical bond did not appear to be an issue of concern for materials studies herein
  - Modified bond test has potential to become a “pass/fail” requirement
- Final Report: http://www.lrrb.org/media/reports/201441.pdf

MnROAD PCC Preservation Research

Full-Depth repairs using Roller Compacted Concrete (RCC)

Advantages:

- **Early open to traffic (if patch area small)**
- **Early strength mixes are possible**
- **Cost can be lower than HMA or PCC materials**
- **Can place with common repair/patching equipment**

Challenges:

- **Must determine amount of compaction provided by roller (surcharge height)**
- **Variable texture (not an issue for small patches)**
- **Cannot apply heavy loads early when used for larger repair areas**
- **May be difficult to tie-into neighboring slabs (should be researched)**

MnROAD 2015 Activities

Full-depth Repairs with RCC

Trial slab to determine surcharge before compaction

MnROAD 2015 Activities

Full-depth repairs using RCC

Cell 38 – 6” JPCP

Cell 305 – 5” UBOL

Cell 162 – 4” BCOA
(removed spring 2016)

Applied 80k MnROAD truck loading within 18 hours
(no visible cracking)

MnROAD 2015 Activities

Full-depth Repairs Using Precast Concrete Panels

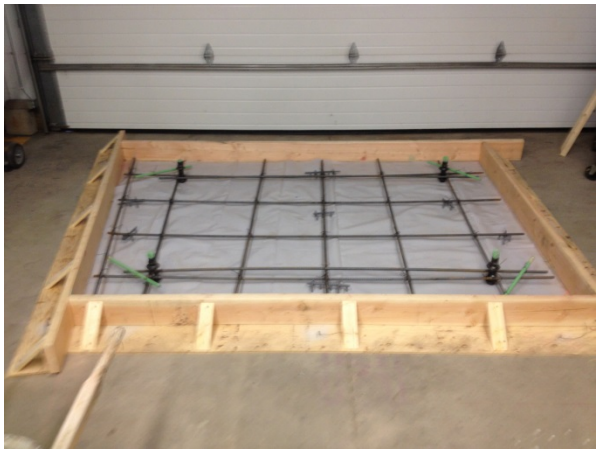
Advantages:

- **Early open to traffic**
- **Place with common equipment (skid loader)**
- **Durability (internal reinforcement for transport)**
- **Can be placed in inclement weather conditions**

Challenges:

- **Must place on level surface or use leveling slurry**
- **Tying into neighboring slabs can slow process**

Precast Repair Panels



Cast 6” thick slab in garage on Jan 29th, 2015

Placed on leveling slurry (frost not completely out of ground)

Installed on March 10th, 2015 using skid loader

MnROAD 2015 Activities

Cell 38 Precast Repair

Very good performance to date

Questions?

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