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16. Abstract (Limit: 250 words)

As Portland cement concrete (PCC) pavements age, longitudinal and transverse joints can exhibit signs of distress as a result of traffic loading, climatic variations, materials related issues, and construction defects. Although only small areas are often involved, the joint distress can substantially disrupt traffic flow and increase pavement roughness sacrificing consumer ride comfort. When immediate action is required, temporary repairs are often made using readily available materials, such as cold mix or other asphalt materials. These temporary materials are oftentimes replaced at a later date with more permanent materials to re-establish the integrity and functionality of the concrete pavement. The goal of this project is to provide a guide for MnDOT and other agencies to establish an effective joint repair program. The final report will guide the reader through product selection, installation techniques, equipment needed for completing the repair, typical performance cost, along with the life expectancy of the repair products. This report provides information on the construction of the patches and their condition after the first year of use.

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Report for Effective Long-Lasting PCC Partial Depth Joint Repairs for Challenging Conditions

Installation through 1st Year Performance

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LIST OF ABBREVIATIONS

Below are the abbreviations for each patch type.

- CL: Centerline
- CLJ: Centerline Joint
- FL: Full Length
- CP: Corner Patch
- WP: Wheel Path
- ML: Mid-Lane
- MLJ: Mid-Lane Joint

Please refer to Figure 3.1 for orientation of each patch type.

EXECUTIVE SUMMARY

As Portland cement concrete (PCC) pavements age, longitudinal and transverse joints can exhibit signs of distress as a result of traffic loading, climatic variations, materials related issues, and construction defects. Although only small areas are often involved, the joint distress can substantially disrupt traffic flow and increase pavement roughness, sacrificing consumer ride comfort. When immediate action is required, temporary repairs are often made using readily available materials, such as cold mix or other asphalt materials. These temporary materials are oftentimes replaced at a later date with more permanent materials to re-establish the integrity and functionality of the concrete pavement.

This research project is being conducted to review alternative patch materials for PCC partial depth repairs and monitor whether these alternative materials last longer than the frequently used cold mix and asphalt patches.

To conduct this research, distresses were made manually within the PCC pavement along the old I-94 westbound at the Minnesota Road Research Facility (MnROAD). This report details the distresses that were patched, what products were used, how they were mixed, and how they were applied. MnDOT Research, District, material suppliers, and Braun Intertec personnel were onsite during the preparation and installation process to document the procedures required or used by each product. Documentation included equipment needed for preparation, manufacturer guidelines or recommendations for the installation of each product and the Personal Protective Equipment (PPE) needed during preparation and application of the repair product.

Additionally, this report provides updates on the condition of the patches after the first year of service. The conditions of the patches were rated on a scale of 0 to 4, with 0 being a failed patch and 4 being a patch with no signs of distress. Discussion of the patch conditions and photos of the patches are included in this report.

CHAPTER 1: OBJECTIVES

Joint distress can range from minor spalling that requires no immediate action to major distresses that can affect large areas of the pavement and significantly disrupt traffic. When immediate action is required, temporary repairs are often made using readily available materials, such as cold mix or other asphalt materials. These temporary materials are oftentimes replaced at a later date with more permanent materials to re-establish the integrity and functionality of the concrete pavement.

When longer-lasting materials are used in the initial joint repairs, the impact to travelers is reduced and additional costs for temporary materials and subsequent removals are eliminated. Different material types are available for longer-term repairs which vary widely in cost, required skill level for satisfactory placement, and time needed before opening to traffic. The performance of each of these materials can also vary widely making selection and installation of permanent repairs challenging.

The objective of this project is to provide a guide for NRRA members and other agencies to establish an effective partial depth repair program for concrete pavements. The final report will guide the reader through product selection, installation techniques, equipment needed for completing the repair, typical performance cost, along with the life expectancy of the repair products.

CHAPTER 2: PROJECT BACKGROUND

The NRRA Preventive Maintenance team selected the original westbound lanes of I-94 that are adjacent to the MnROAD Facility to perform this research project. This portion of I-94 was originally constructed in 1973 with a 9-inch thick concrete pavement and skewed 27-foot spaced transverse joints. A total of 15 test sections consisting of three contiguous panels and two transition panels, one at either end, were prepared. Seven different patch types were created as shown in Figure 3.1. Sixteen different proprietary products were supplied by vendors for evaluation. Additionally, asphalt patching mix was used in two of the 15 sections.

MnDOT Research, MnDOT District, material suppliers, and Braun Intertec Corporation (Braun) personnel were onsite during the preparation and installation process to document the procedures required and/or used for each product. Documentation included equipment needed for preparation, manufacturer guidelines or recommendations for the installation of each product and the Personal Protective Equipment (PPE) needed during preparation and application of the repair product.

The patches were installed during October 2017. Westbound I-94 traffic was placed on the partial depth patch sections beginning November 2, 2017 and remained there until November 21, 2017. Traffic is not usually placed on the old I-94 Westbound section during winter months. As such, traffic was not placed back on the partial depth patch sections until March 12, 2018 and remained there intermittently through August 27, 2018.

In total, the partial depth patch section carried traffic for 61 days between the installation date and August 27, 2018. In that time, over 1.5 million passenger cars and 237,000 heavy commercial trucks drove over the partial depth patches. The traffic data is broken down into further detail in Table 2.1.

Table 2.1 Traffic Data between Patch Installation and First-Year Review

Lane	Dates	Total Number of Cars	Total Number of Heavy Commercial Trucks	WIM Measured CESALs
Driving	Winter (11/2/17 to 5/29/18)	464,720	128,688	176,733
	Summer (8/13/18 to 8/27/18)	179,611	48,283	65,382
	Total (11/2/17 to 8/27/18)	*644,311*	*176,971*	*242,115*
Passing	Winter (11/2/17 to 5/29/18)	613,316	40,615	32,871
	Summer (8/13/18 to 8/27/18)	262,800	20,106	19,216
	Total (11/2/17 to 8/27/18)	*876,116*	*60,721*	*52,087*

The first-year review of the patch conditions was performed on two separate dates: June 20, 2018 and September 15, 2018. It was noted on June 20, 2018 that patch conditions were generally good after the "winter traffic", so it was decided that the patches should be observed again after the summer months. The conditions of the patches are discussed in Chapter 5. Photographs of the patches are included in Appendix B.

CHAPTER 3: DISTRESS DESIGN

A rotary head milling machine was used to create the distress areas (distress). The process of milling was more aggressive than anticipated and created much larger areas – both in width and depth – than would typically receive partial depth patching. As such, some of the material providers did not have enough material on-hand to patch all the distresses in a test cell. Some of the test cells contain two different patch materials to accommodate for the lack of product. The layout of patch materials used for each distress within each test cell are described in detail in Chapter 5.

Each distress was air blasted to remove the loose rubble left after the milling process. Several distresses were then sand blasted. However, due to a restricted time window and for the sake of streamlining the installation of the patches, not all of the distresses were sand blasted. Chapter 5 details which distresses were sand blasted in the observations of each individual cell. A final cleaning with a traditional leaf blower was performed in each distress before patch material was placed.

The figure below provides the typical patching types and locations within a test cell. Note that the order of the patching types varies within each cell, but each cell contains all types. The actual order of the patching types for each test cell are shown in Chapter 5.

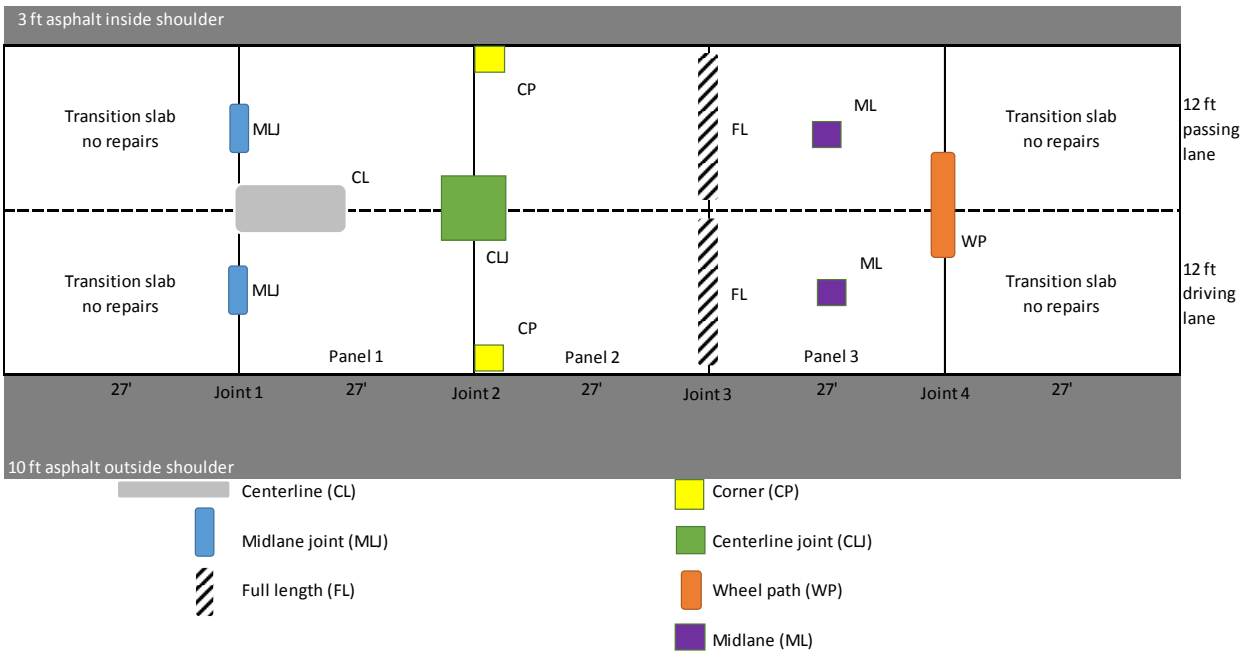

Figure 3.1 Typical Layout of Patching Types for PCC Partial-Depth Repair Study

CHAPTER 4: CONDITION RATING SCALE

MnDOT and Braun personnel developed a rating scale to use when reviewing the patch conditions. This scale is based on whether the original patch still exists and if so, what condition it is in. The scale ranges from 0 to 4, with 0 meaning the patch has failed and has been replaced, and 4 meaning the patch is intact and shows no signs of distress. Although the rating scale is only being used to review the PCC and non-HMA proprietary products, all of the patches were reviewed. The intention is to compare the "patch life" for typical HMA patches versus the proprietary product patches.

Note that shrinkage cracks are not considered a distress in this review. Shrinkage cracks are not identified in MnDOT's Pavement Distress Identification Manual; however, they are common in concrete pavements. Shrinkage cracks are hairline cracks at the surface that develop during the setting and curing of concrete and typically do not extend through the entire depth of the patch or slab. As such, these cracks were not considered to decrease the integrity of the patches.

Table 4.1 depicts the details of the rating scale. The ratings of the patches within each test cell are discussed in Chapter 5 and included in Appendix B with the corresponding patch photos.

Table 4.1 Patch Condition Rating Scale

Rating	Patch Condition Description
4	Excellent; 100% of patch is intact, only shrinkage cracks present
3	Good; distresses (cracking and debonding) exist, but 100% of original patch is in place
2	Fair; less than 50% of the original patch is gone/been replaced
1	Poor; over 50% of the original patch is gone/been replaced
0	Failed; original patch no longer exists

CHAPTER 5: CONSTRUCTION AND PATCH CONDITIONS

During the installation process, it was decided to document how the material was installed, not necessarily what the best practices are. The Material Technical Data Sheets (MTDS) were reviewed to determine any best practices for each product and to determine more detailed information on the installation techniques and preparation needed of the patch.

It was observed that the patch materials came in a variety of packaging. There may be options for bulk quantities for larger repair projects. Some were contained in bags that are not waterproof while some were contained in buckets or waterproof materials. However, it should be noted that many of the materials are available in different sizes or quantities. The MTDS were reviewed for “shelf life” and storage requirements of each material. These items may play a role in deciding the appropriateness of each material for storage at maintenance facilities.

It was also noted that some materials required a mixer other than the standard revolving drum mixer that most maintenance crews currently utilize. Several products preferred and some required a mortar or shearing mixer. A few of the products could be mixed with a simple drill mixer with a paddle attachment. The mixing procedures are detailed in Chapter 5. The MTDS were also reviewed for any Standard Operating Procedures (SOP) for mixing each product as some suppliers were involved in mixing the product.

The curing time also varied amongst products. The MTDS provide generalized timeframe at varying temperatures along with the curing procedures for each material. The re-establishment of the joint was a large topic of discussion during the installation. Some suppliers utilized foam board or cardboard or a combination thereof. Some suppliers requested that their patches be sawed. It was observed during the installation that the foam board or cardboard was difficult to use, as it would routinely float in the material and needed to be weighted down. The sawing time to establish joints in the patches for some of the materials may have been too long to minimize the potential for cracking.

Figures 5.1 through 5.21 detail the patches and products placed in each cell. Below each figure is a discussion about the installation process of that product and about the condition of the patch material during the first-year review.

Cell 94001 – CTS, Rapid Set DOT Repair Mix

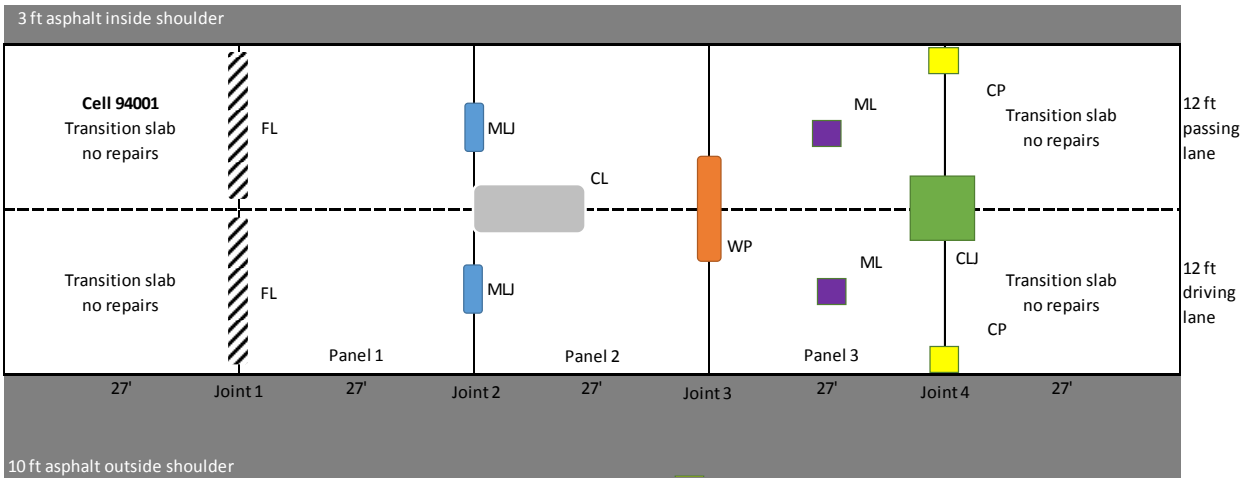

Figure 5.1 Patch Layout for Cell 94001 – CTS, Rapid Set DOT Repair Mix

The driving and passing lane were both sandblasted for this cell. Rapid Set DOT repair mix is a bagged product, 55 pounds. Approximately one 5-gallon bucket of 3/8-inch granite chips was added for each bag of mix added to the mixer, along with approximately 5 quarts of water per bag. The mixture was mixed for 3 minutes in a revolving drum mixer to provide the consistency desired. The mixture was then placed into a wheel barrow and transported to the patches. The material was finished with traditional concrete tools. The patches were pre-wetted before placing material. Foam board was used to re-establish joints and patches were cured with plastic sheeting. The passing lane FL joint was mixed in a wheel barrow and had a higher water-to-cementitious ratio than the other patches.

During the first-year review, the patches were exhibiting minor shrinkage cracks but no signs of further distress. The image below shows the general condition of the patches in Cell 94001. Each of the patches within Cell 94001 received a rating of 4.

Figure 5.2 Cell 94001 – General patch condition, minor shrinkage cracks (Rating – 4)

Cell 94002 – SpecChem, RepCon 928 and Hot Mix Asphalt

94002 (A) – SpecChem, RepCon 928

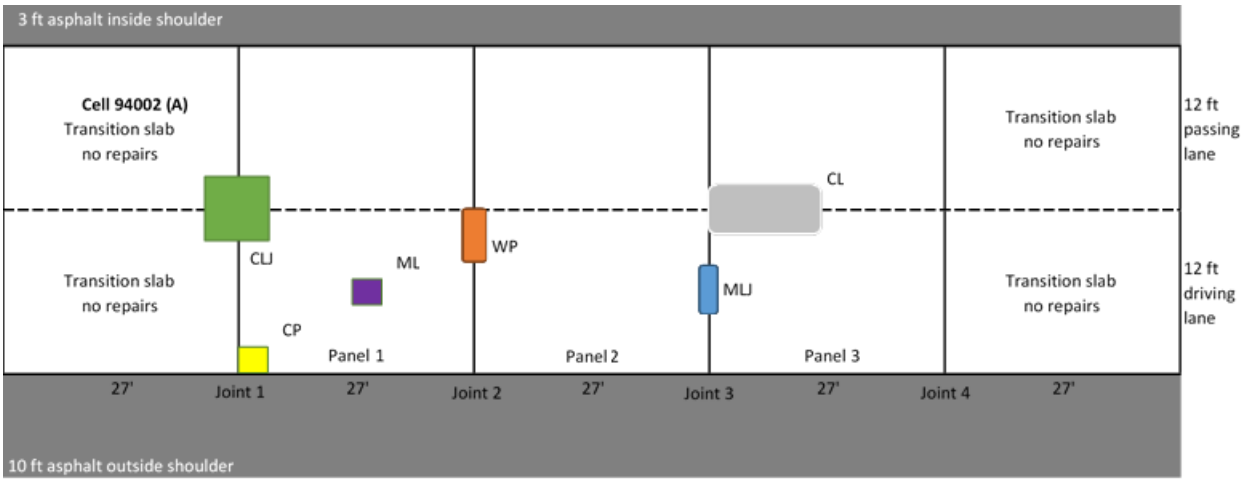

Figure 5.3 Patch Layout for Cell 94002 (A) – SpecChem, RepCon 928

The driving and passing lane were both sandblasted for this cell. RepCon 928 is a bagged product, 50 pounds. Approximately 2.5 quarts of water per bag were added in the mixer and mixed for 3 minutes in a revolving drum mixer. The mixture was then placed into a wheel barrow and transported to the patches. The material was finished with traditional concrete tools. The patches were pre-wetted before placing material. Foam board was used to re-establish some joints while others were sawed, and patches were cured with plastic sheeting. Some cracking was noted in some patches the next day.

It was noted during the first-year review that the patches had developed some fine linear cracks but were still fully intact. These patches were given a rating of 3. Figure 5.4 shows the general condition of the patches in Cell 94002 (A).

Figure 5.4 Cell 94002 (A) – General patch condition, linear cracks present (Rating – 3)

94002 (B) – Hot Mix Asphalt

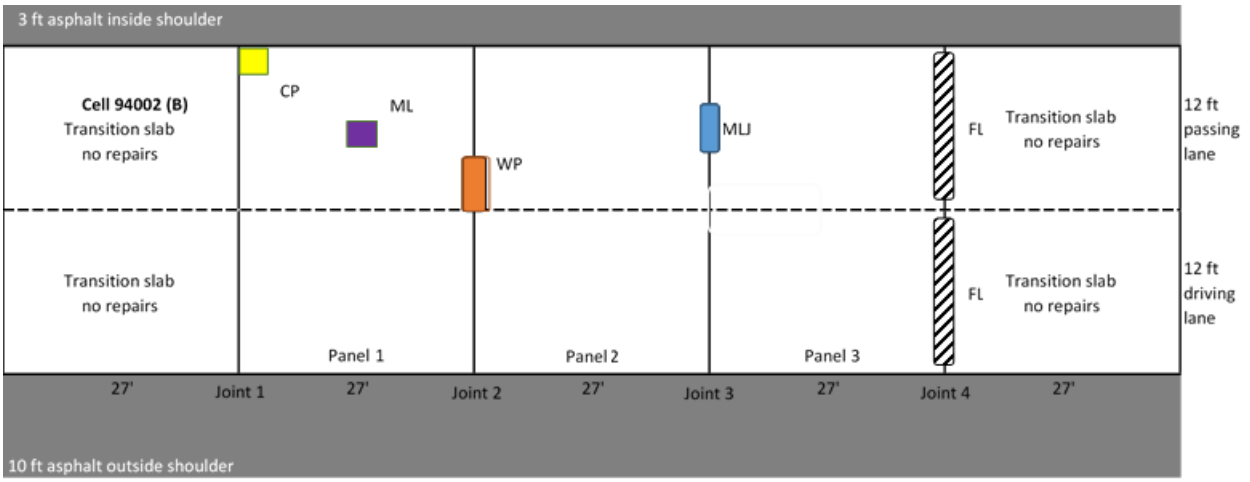

Figure 5.5 Patch Layout for Cell 94002 (B) – Hot Mix Asphalt

The passing lane CP, ML, WP, and MLJ and both FL patches were completed with HMA due to the amount of product required for the patches. The HMA material was installed similarly to the procedure described for Cells 94014 and 94015, which were all HMA material.

The HMA patches in Cell 94002 (B) did not show any signs of distress and no photographs were taken during the first-year review.

Cell 94003 – Western Material and Design (2 products)

94003 (A) FasTrac 246

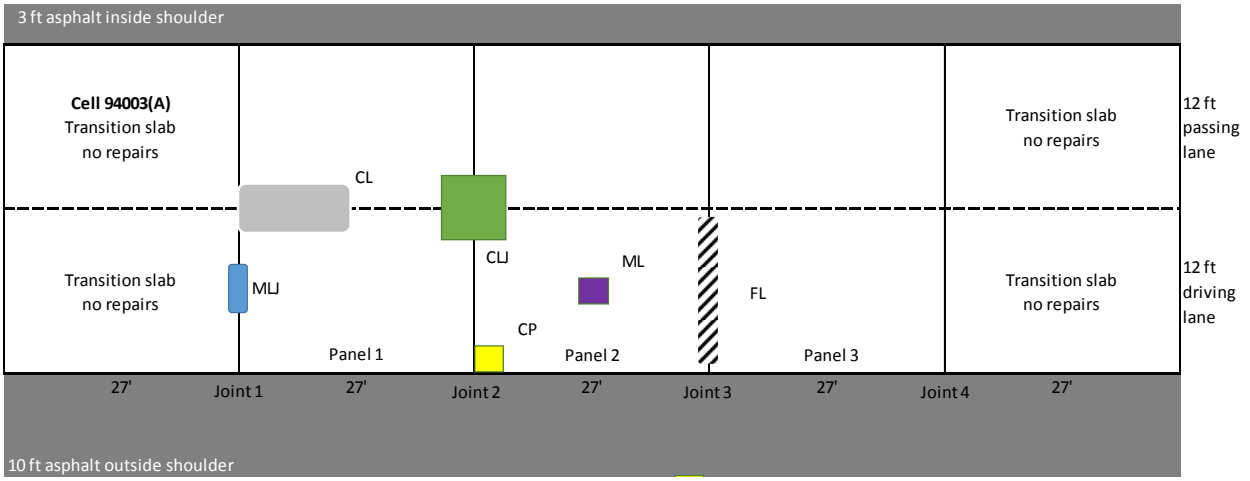

Figure 5.6 Patch Layout for Cell 94003 (A) – Western Material and Design, FasTrac 246

The driving lane and passing lane were both sandblasted. FasTrac 246 is a bagged product, 60 pounds. Approximately 2 quarts of water per bag were added in the mixer. The supplier utilized their own mixer which was a "screw" type mixer. The mixer attached to the front of a skid steer and was used to mix as well as place the concrete in the patches. The material was finished with traditional concrete tools. The patches were pre-wetted before placing material. Foam board was used to re-establish some joints while others were sawed. The patches were cured with plastic sheeting.

The patches in Cell 94003 (A) did not show any signs of distress and no photographs were taken during the first-year review. The patches were rated 4.

94003 (B) CE 700 HPC

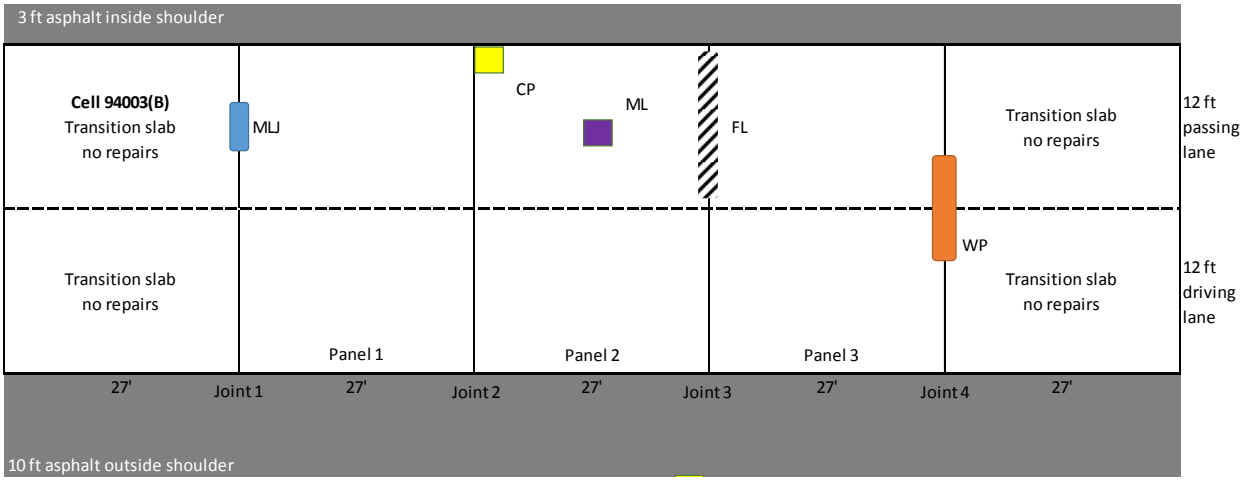

Figure 5.7 Patch Layout for Cell 94003 (B) – Western Material and Design, CE 700 HPC

The passing lane was sand blasted with the exception of the FL and WP repairs. The driving lane for the WP repair was sand blasted. CE 700 HPC is a 3-part system. Before mixing, the material was heated to approximately 70 to 80 degrees Fahrenheit. Part A (liquid polymer, 4 gallons) and Part B (liquid polymer, 4 gallons) are poured into the mixer and mixed for approximately 3 minutes. Then Part C (aggregate, 12 50-pound bags) was added. The supplier utilized their own mixer which was a “screw” type mixer. The mixer attached to the front of a skid steer and was used to mix as well as place the concrete in the patches. The material is finished with traditional concrete tools. Aggregate was broadcast onto the surface for added slip resistance. Cardboard was used to re-establish joints. The patches were not pre-wetted and were not cured.

The patches in Cell 94003 (B) did not show any signs of distress and no photographs were taken during the first-year review. The patches were rated 4.

Cell 94004 – D.S. Brown, PaveSaver Polymeric Concrete Patch and Crafco, HP Concrete Cold Patch

94004 (A) – PaveSaver Polymeric Concrete Patch

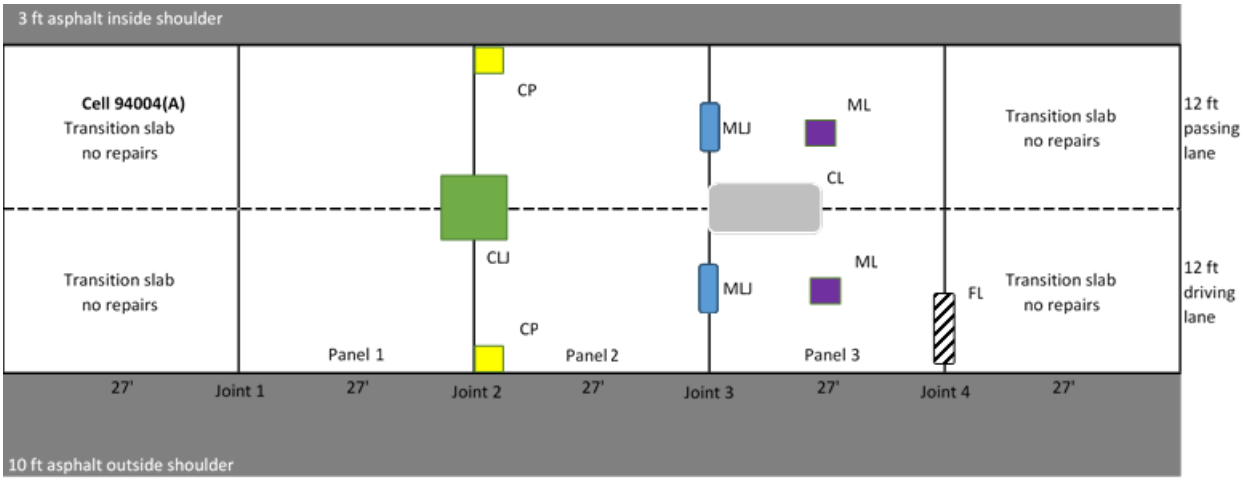

Figure 5.8 Patch Layout for Cell 94004 (A) – D.S. Brown, PaveSaver Polymeric Concrete Patch

The driving lane was sand blasted for all repairs while the passing lane was sand blasted only for the CL and ML repairs. PaveSaver Polymeric Concrete Patch is a 3-part system. Part A (1-gallon gray liquid) and Part B (1-gallon clear liquid) were poured into a 5-gallon bucket and mixed with a drill mixer with a paddle attachment for 3 minutes. The paddle mixer was placed towards the bottom of the bucket to minimize the introduction of air into the mixture. Part C (aggregate, 2 50-pound bags) was then placed into the bucket while mixing continued until the desired consistency was achieved. The material was poured from the bucket into the patch. The material was finished with traditional concrete tools. Cardboard was used to re-establish joints. The patches were not pre-wetted and were not cured.

The patches in Cell 94004 (A) did not show any signs of distress and no photographs were taken during the first-year review. The patches were rated 4.

94004 (B) – Crafco, HP Concrete Cold Patch

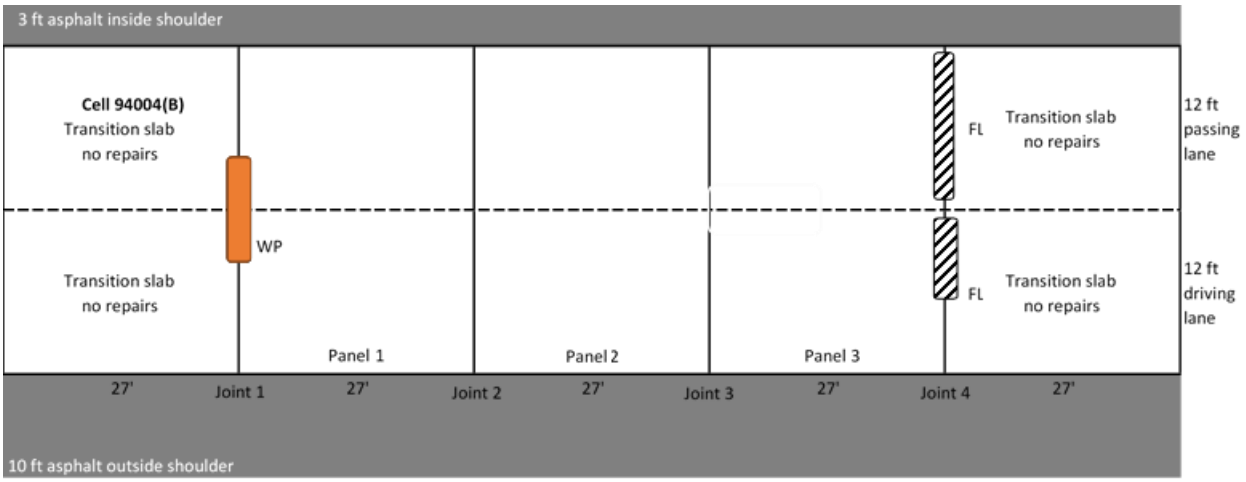

Figure 5.9 Patch Layout for Cell 94004 (B) – Crafco, HP Concrete Cold Patch

The WP, passing lane FL, and about half of the driving lane FL repairs were patched with the Crafco, HP Concrete Cold Patch, due to a lack of PaveSaver materials. The HP Concrete Cold Patch material was placed similarly to the procedure described for Cell 94009.

The patches in Cell 94004 (B) did not show any signs of distress and no photographs were taken during the first-year review. The patches were rated 4.

Cell 94005 – FastPatch DPR

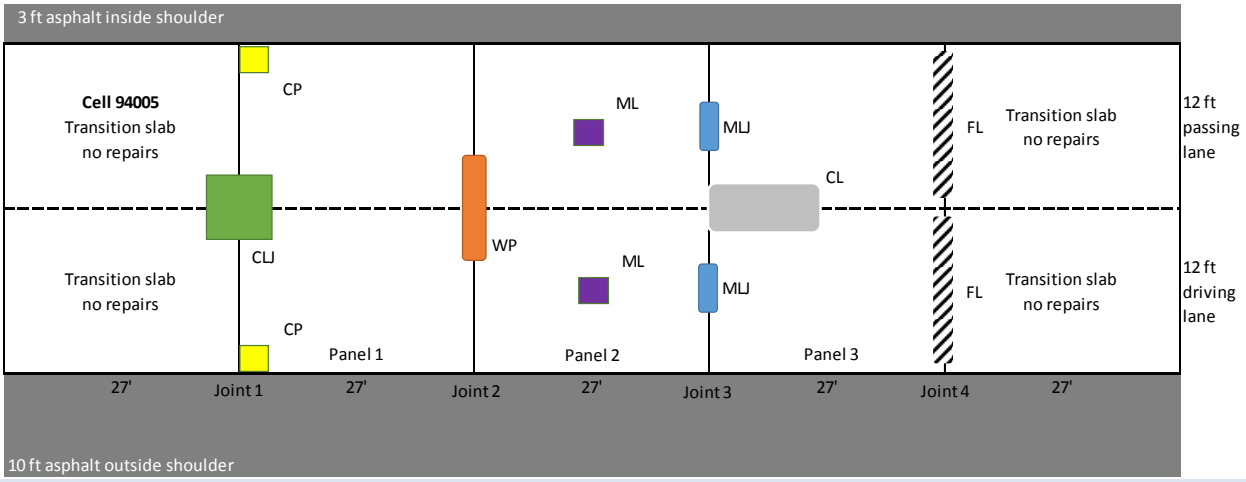

Figure 5.10 Patch layout for Cell 94005 – Willamette Valley Company, FastPatch

The driving lane was sandblasted for all repairs and the passing lane was sand blasted for the CLJ and CL repairs. FastPatch is a 3-part system wholly contained in a 5-gallon bucket. Part A (11 liters) and Part B (6 liters) are packaged in separate packets inside the bucket while Part C (2.5 liters) is "loose" aggregate in the bucket. The mixing required a drill with a paddle attachment. Part A was added to Part C while mixing for 2 minutes then Part B was added while mixing for an additional 2 minutes. The material was poured from the bucket into the patch. The material is finished with traditional concrete tools. Foam board was used to re-establish the joints. Aggregate was broadcast onto the surface for added slip resistance. The patches were not pre-wetted and were not cured.

The patches in Cell 94005 did not show any signs of distress and no photographs were taken during the first-year review. The patches were rated 4.

Cell 94006 – Five Star Products (2 Products)

94006 (A) Rapid Surface Repair Easy Mix

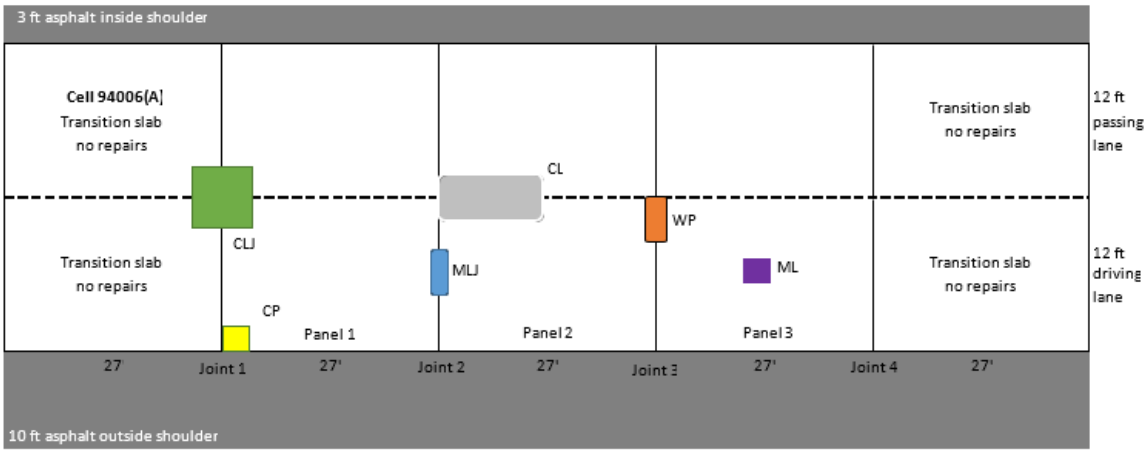

Figure 5.11 Patch Layout for Cell 94006 (A) – Five Star Products, Rapid Surface Repair Easy Mix

The driving lane was sand blasted along with the passing lane for the CL repair. Rapid Surface Repair Easy Mix is a 3-part system. Part A (1.21 liters) and Part B (1.21 liters) are poured into a 5-gallon bucket and mixed using a drill with a paddle attachment for approximately 30 seconds. Part C (50-pound aggregate bag) was added and mixed until the desired consistency was achieved. The material was poured from the bucket into the patch. The material is finished with traditional concrete tools. The patches were heated with a propane torch before placing the material. It was observed that the patches were most likely too large for this material, at least in the provided material sizes. It was difficult to place the material in more than one lift as the previous lift typically hardened before the second lift could be mixed.

The driving lane WP and ML patches had about 50 percent of the patch material missing during the first-year review and were repaired with the Crafco HP Concrete Cold Patch material. These patches were given a rating of 1. The other patches were in generally good condition, with some shrinkage cracks present. However, it was clear to see that the material had set before finishing could be completed. Figure 5.12 shows the general condition of the patches in Cell 94006 (A), which were given a rating of 4.

Figure 5.12 Cell 94006 (A) – General patch condition (Rating – 4)

94006 (B) Rapid Surface Repair Epoxy Fix

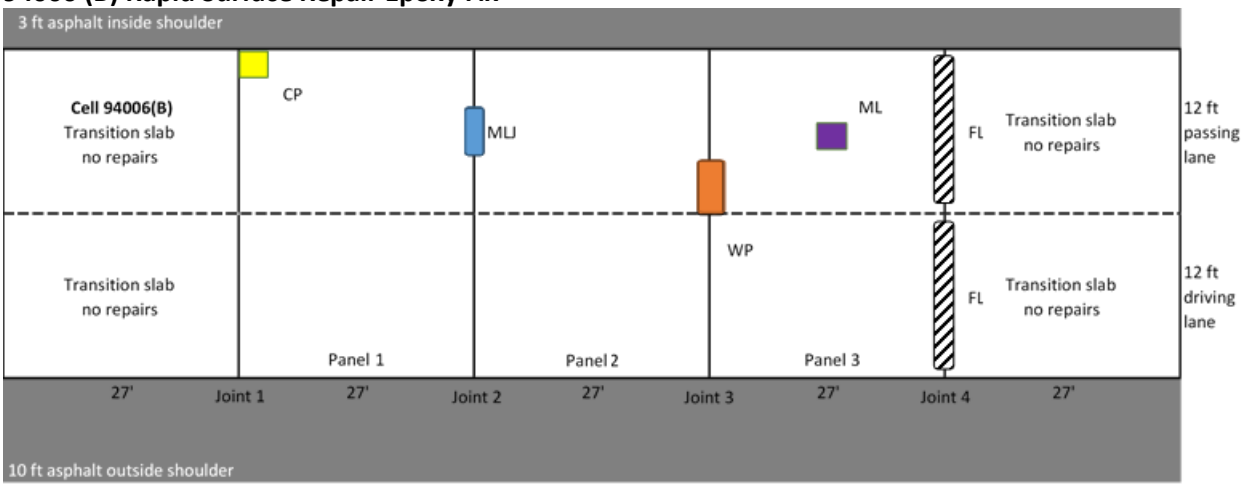

Figure 5.13 Patch Layout for Cell 94006 (B) – Five Star Products, Rapid Surface Repair Epoxy Mix

The passing lane was not sand blasted for these repairs. Rapid Surface Repair Epoxy Mix is a 3-part system. The 3/8-inch granite chips were placed into the patch. The supplier provided a dispensing system contained in a cargo van. The system mixed Part A and Part B together and dispensed the mixed product onto the granite chips. The mixture filled in the voids in the aggregate to fill the patch. The patches were heated with a propane torch before placing the material. Foam board was used to re-establish joints. Aggregate was broadcast onto the surface for added slip resistance. The patches were not cured.

The passing lane MLJ and driving lane FL patches had over 50 percent of the patches repaired with HMA or the Crafco HP Concrete Cold Patch material. These patches have a rating of 1. The remaining patches were in generally good condition, with some minor linear cracks and debonding developing along the edges. These patches were given a rating of 3.

Figure 5.14 Cell 94006 (B) – General patch condition, minor cracks and debonding (Rating – 3)

Cell 94007 – TCC Materials, ProSpec Concrete Patching Mix

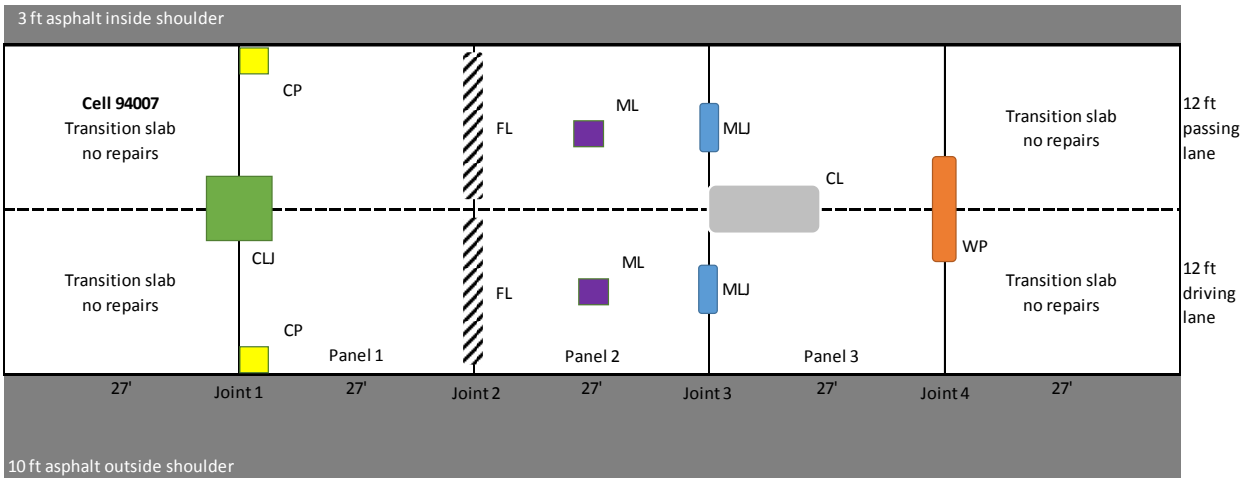

Figure 5.15 Patch Layout for Cell 94007 – TCC Materials, ProsSpec Concrete Patching Mix

The driving lane was sand blasted along with the passing lane for the CLJ and CL repairs. ProSpec Concrete Patching Mix is a bagged product, 50 pounds. Approximately 3 quarts of water was added to the mixture per bag. The mixer required for this product was a paddle or mortar mixer. A revolving drum mixer was not suitable. Mixing continued for 2 to 3 minutes until the desired consistency was obtained. The mixture was then placed into a wheel barrow and transported to the patches. The material was finished with traditional concrete tools. Foam board was used to re-establish joints. The patches were pre-wetted before placing material and curing was completed using plastic sheets.

During the first-year review, the patches in cell 94007 generally showed some debonding and missing material along the edges of the patches. The patches with missing material included the passing lane FL, MLJ and WP, and were given a rating of 2. The other patches each got a rating of 3.

Figure 5.16 Cell 94007 – General condition, minor cracks and missing material (Rating – 2)

Cell 94008 –Aqua Patch Road Materials, Aqua Patch and TCC Materials, ProSpec Concrete Patching Mix

94008 (A) – Aqua Patch Road Materials, Aqua Patch

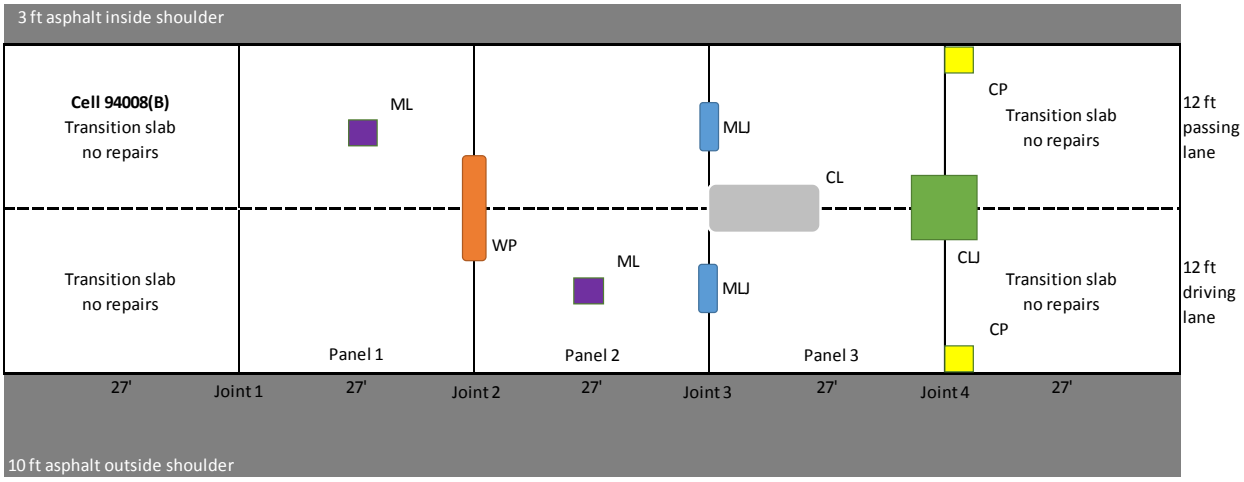

Figure 5.17 Patch Layout for Cell 94008 (A) – Aqua Patch Road Materials, Aqua Patch

The driving lane was sand blasted along with the passing lane for the CL and CLJ repairs. Aqua Patch is a bagged product, 50 pounds. There is no mixing or finishing required. The material is placed into the patch, water added, and tamped down.

The driving and passing lane MLJ along with the driving lane CP have failed and have been repaired. These patches were rated as 0. The majority of the patches are exhibiting significant cracks and missing material along the edges and were rated as 2. Aqua Patch is a material designed for patching HMA pavements. It is not recommended for patching jointed areas or where pavement is designed to move.

Figure 5.18 Cell 94008 (A) – General condition, cracks and missing material (Rating – 2)

94008 (B) – TCC Materials, ProSpec Concrete Patching Mix

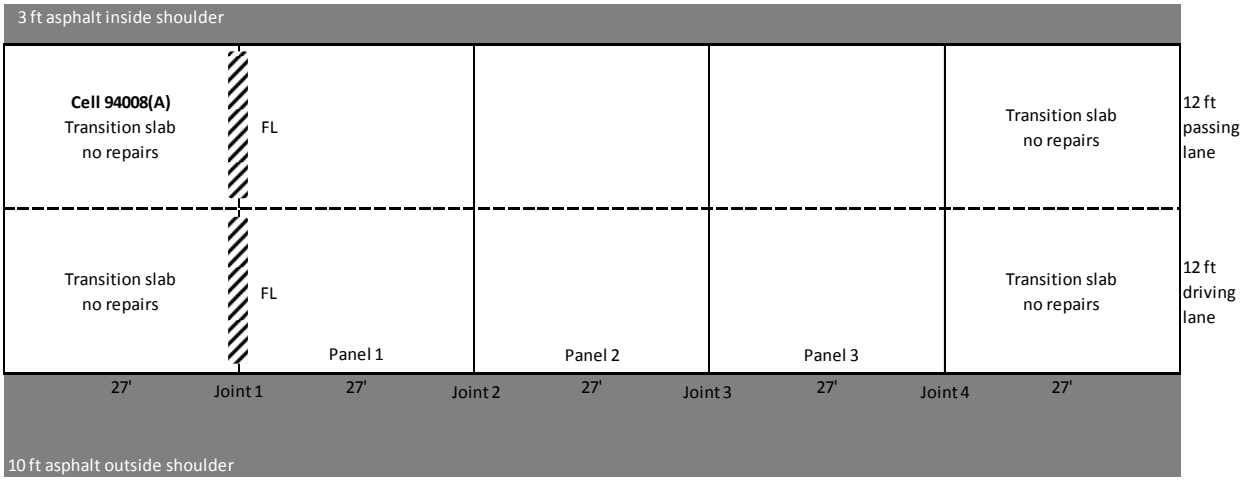

Figure 5.19 Patch Layout for Cell 94008 (B) – TCC Materials, ProSpec Concrete Patching Mix

The driving lane was sand blasted for the FL repair. The procedures for mixing and placing are the same as described for the material as used in Cell 94007.

The passing lane FL patch lost material. Less than 50 percent of the original material was lost, so the patch was rated as 2. The driving lane FL was in generally good condition and given a rating of 4.

Figure 5.20 Cell 94008 (B) – General condition, cracks and missing material (Rating – 2)

Cell 94009 – Crafco, HP Concrete Cold Patch

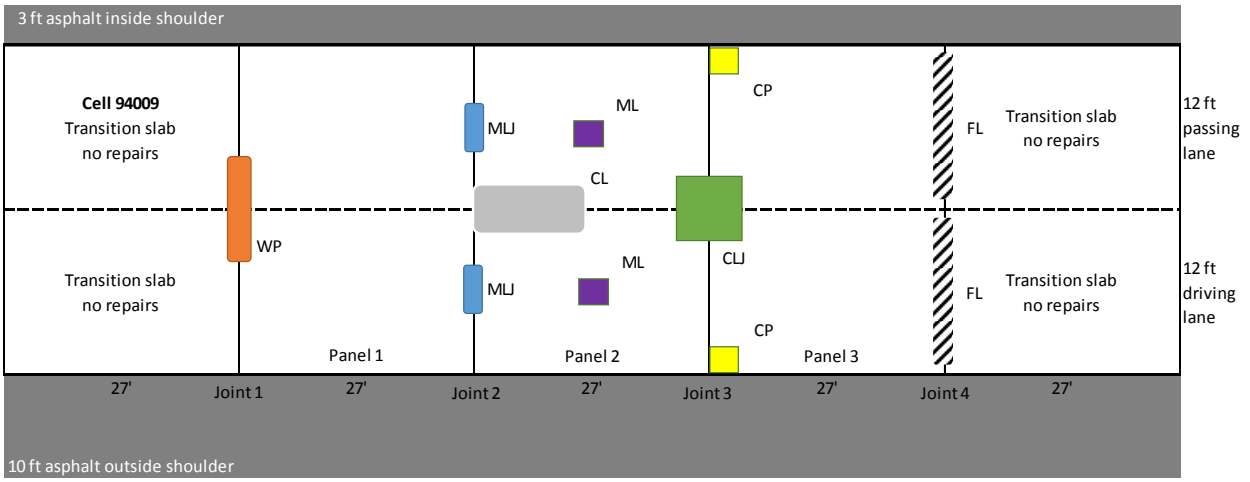

Figure 5.21 Patch Layout for Cell 94009 – Crafco, HP Concrete Cold Patch

The driving lane was sand blasted along with the passing lane for the CL and CLJ repairs. HP Concrete Cold Patch is a bagged product, 50 pounds. The material was placed in 2-inch lifts in patches where required. Each lift was compacted via a hand tamper. The final layer was placed approximately 1/2 inch above the top of the patch and hand tamped. There is no finishing of the material required. A bond breaker or Portland cement was used on the surface. The supplier then proceeded to drive back and forth over the product for final compaction.

During the first-year review, the patches were exhibiting no signs of distress, although most of the patches had settled to some degree. An additional layer was added to the driving lane FL patch due to settling. All of the patches in Cell 94009 were rated as 4.

Figure 5.22 Cell 94009 – General patch condition (Rating – 4)

Cell 94010 – Crafco, Techrete-TBR

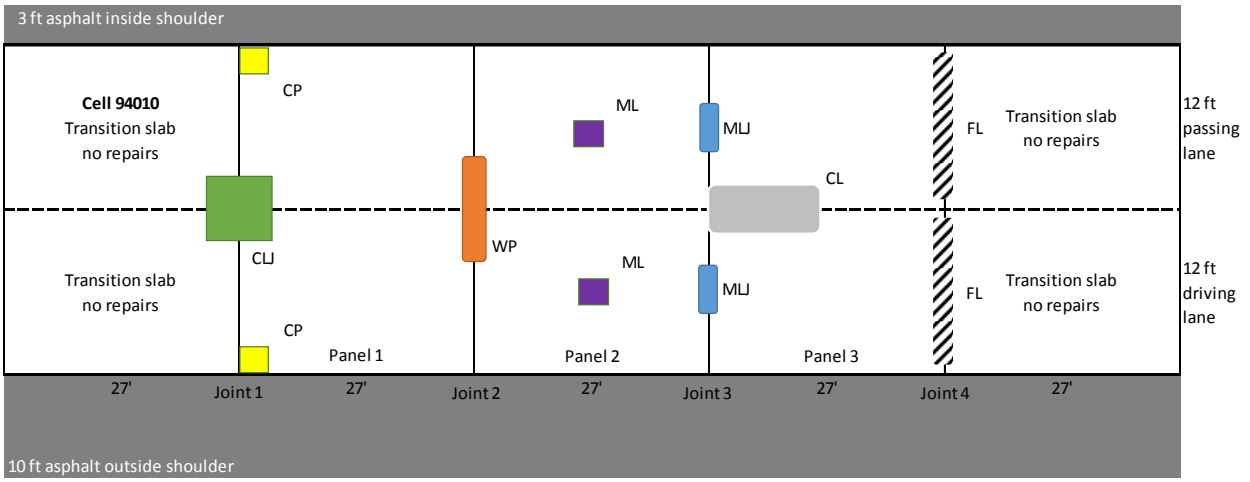

Figure 5.23 Patch Layout for Cell 94010 – Crafco, Techrete-TBR

Sand blasting was performed for all patches in the driving lane, and the passing lane CLJ. Techrete-TBR is a hot applied flexible mastic sealant. The material is in melt-able bags weighing 35 pounds, and heated and mixed in a melter to approximately 400 degrees Fahrenheit. The melter used in this application was a Crafco Patcher II. It was reported that most MnDOT districts have an approved melter that can be used for the Techrete-TBR patches. The melter is placed directly over the patch and the material moves down the shoot into the patch. Although sandblasting is not required, it is preferred. A primer is applied to each distress and dried before material is placed. There is no need to re-establish joints as the material should move with the slab. For deeper patches, material can be placed in two lifts. The first layer should "set" before the second lift is placed. The edges are finished with a heated tool, similar to a float used for traditional concrete finishing. An aggregate can be broadcast onto the surface for slip resistance although none was broadcast during the placement. Once the material has cooled it can be opened to traffic.

The patches were exhibiting no signs of distress during the first-year review and were rated 4.

Figure 5.24 Cell 94010 – General patch condition (Rating – 4)

Cell 94011 – TCC Materials, 3U18 Modified

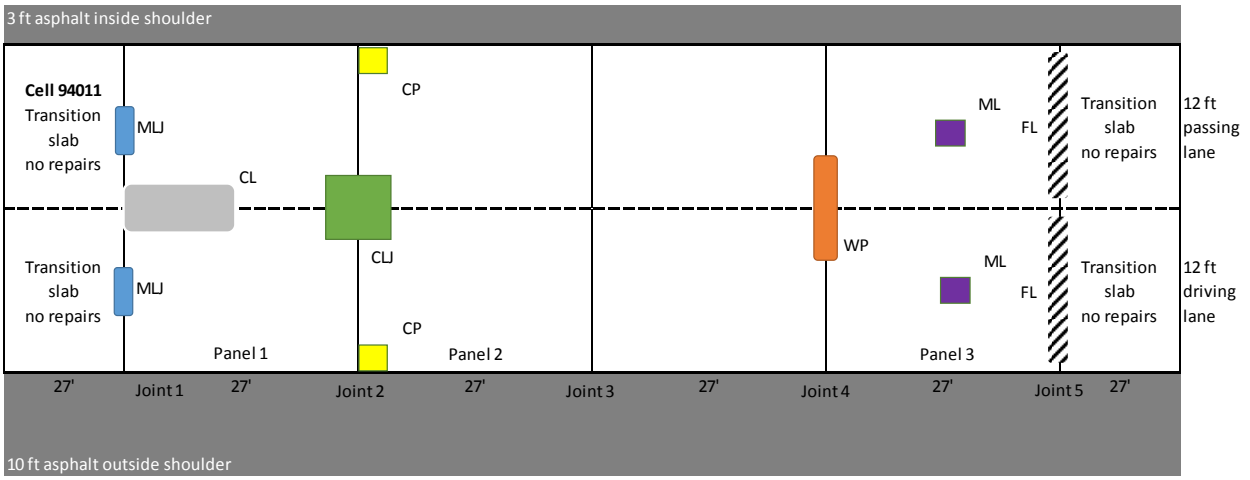

Figure 5.25 Patch Layout for Cell 94011 – TCC Materials, 3U18 Modified

The driving and passing lane were sand blasted. 3U18 Modified is a bagged product, 50-pound bags. Water was added to the product until an approximate 10-inch slump was achieved continuing the mixing for approximately 6 minutes. MnDOT also added two admixtures; one was reported to be an accelerating admixture, and the second was a water reducer. A revolving drum mixer was utilized to mix the product. The mixture was then placed into a wheel barrow and transported to the patches. The material was finished with traditional concrete tools. The patches were saw cut to re-stablish joints. The patches were pre-wetted before placing material and curing was completed using plastic sheets.

The patches were generally not exhibiting any signs of distress during the first-year review. Some patches developed shrinkage cracks. All of the patches in Cell 94011 were rated as 4.

Figure 5.26 Cell 94011 – General patch condition (Rating – 4)

Cell 94012 – USG Ecofix

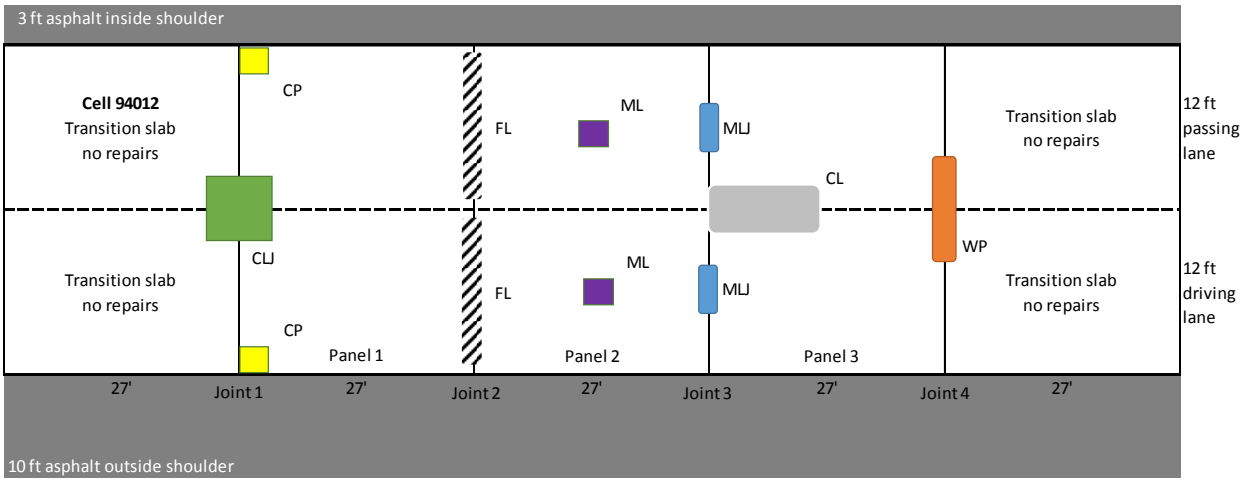

Figure 5.27 Patch Layout for Cell 94012 – USG Ecofix

The driving and passing lane were sand blasted. USG Ecofix is a bagged product, 50 pounds. Approximately 32.5 pounds of 3/8-inch granite chips and approximately 2.25 quarts of water were added per bag. The mixture was mixed in a revolving drum mixer for 2 to 3 minutes until the desired consistency was obtained. The mixture was then placed into a wheel barrow and transported to the patches. The material was finished with traditional concrete tools. The patches were pre-wetted and saw cutting was utilized to re-establish the joints. The patches were cured with plastic sheets.

Most of the patches were showing no signs of distress and were rated as 4. However, the CLJ patch developed a corner break and additional cracking and was rated 3.

Figure 5.28 Cell 94012 – CLJ patch, corner break and cracking (Rating – 3)

Cell 94013 – CTS, Rapid Set DOT Repair Mix and Helix Steel Fibers (2 fiber products)

94013 (A) – CTS, Rapid Set DOT Repair Mix and Helix 5-25-Standard BA (Zinc Coated) Fibers

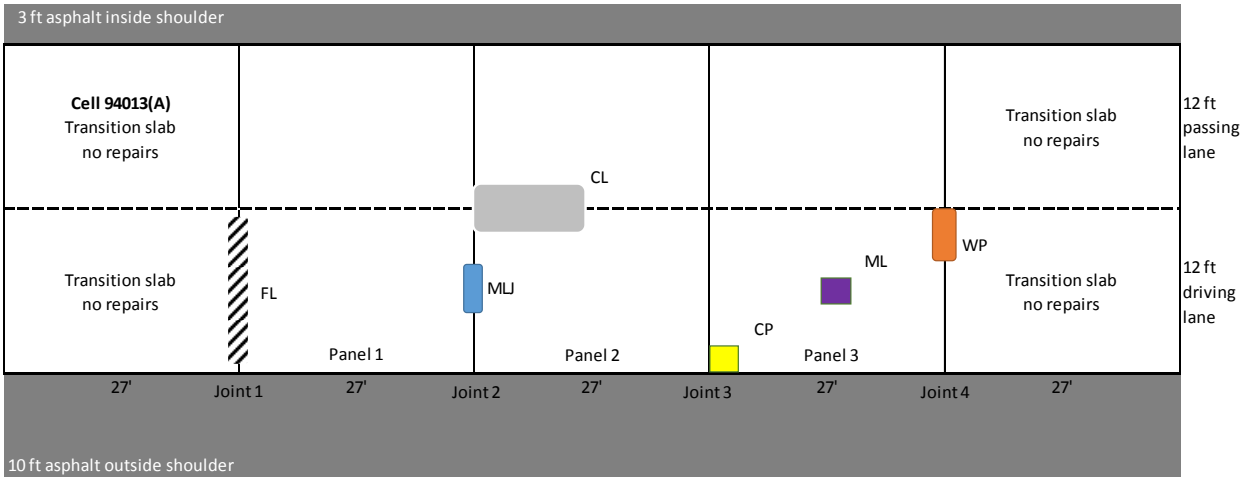

Figure 5.29 Patch Layout for Cell 94013 (A) – CTS, Rapid Set DOT Repair Mix and Helix 5-25-Standard BA (Zinc Coated) Fibers

The driving and passing lane were sand blasted. The material is a bagged product, 55 pounds, that was used in cell 94001. Approximately one 5-gallon bucket of 3/8-inch granite chips were added for each bag of material in the mixer along with approximately 5 quarts of water per bag. Helix zinc coated fibers were added to the mixture at the rate of 2 pounds per bag. The fiber was added to the granite chips and mixed before addition of the bagged product. Everything was mixed for approximately 3 minutes in a revolving drum mixer to provide the consistency desired, and then placed into a wheel barrow and transported to the patches. The material was finished with traditional concrete tools. The distresses were pre-wetted before placing material. Foam board was used to re-establish joints and patches were cured with plastic sheeting.

During the first-year review, some of the patches had developed shrinkage cracks and the driving lane WP had a crack along the edge of the patch. Most of the patches were rated 4, but the WP was rated 3.

Figure 5.30 Cell 94013 (A) – WP patch, cracking along edge (Rating – 3)

94013(B) - CTS, Rapid Set DOT Repair Mix and Helix 5-25-SS BA (Stainless Steel)

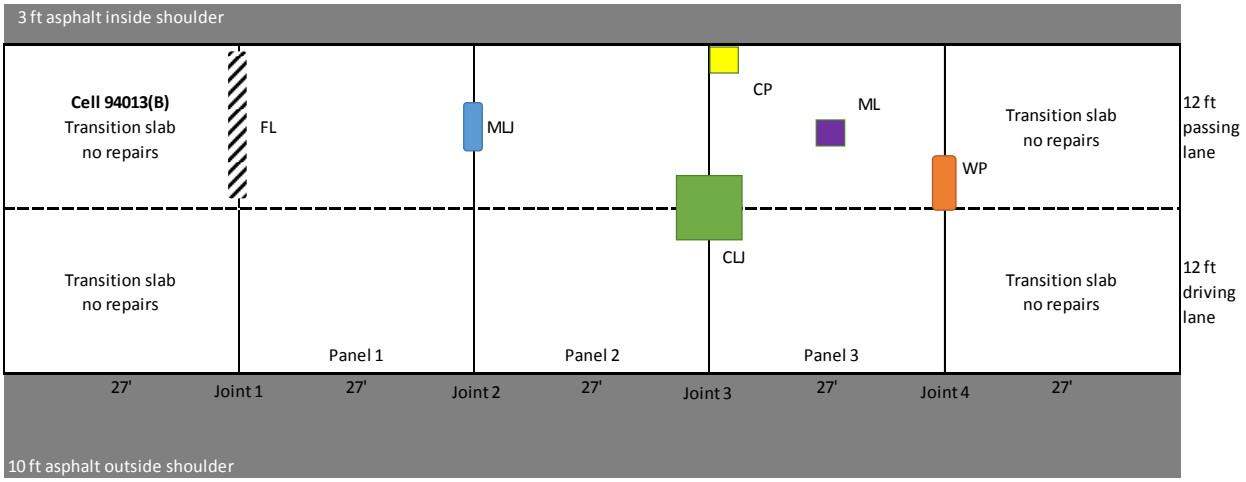

Figure 5.31 Patch Layout for Cell 94013 (B) – CTS, Rapid Set DOT Repair Mix and Helix 5-25-SS BA (Stainless Steel)

The driving and passing lane were sand blasted. The mixing procedures were the same as for Cell 94013 (A) with the difference being the utilization of stainless-steel fibers instead of zinc coated.

The patch conditions were generally similar to Cell 94013 (A) as well, with some patches having shrinkage cracks. Most of the patches were rated 4. The CLJ patch developed a crack near the edge of the original distress and was rated as 3.

Figure 5.32 Cell 94013 (B) – CLJ patch, cracking near edge (Rating – 3)

Cell 94014 and 94015 – Hot Mix Asphalt

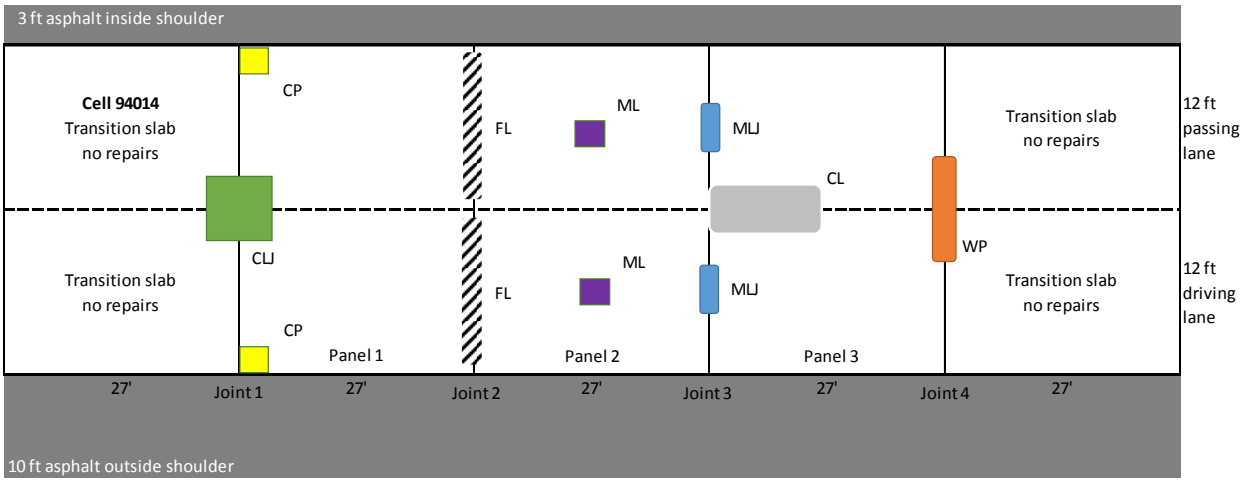

Figure 5.33 Patch Layout for Cell 94014 – Hot Mix Asphalt

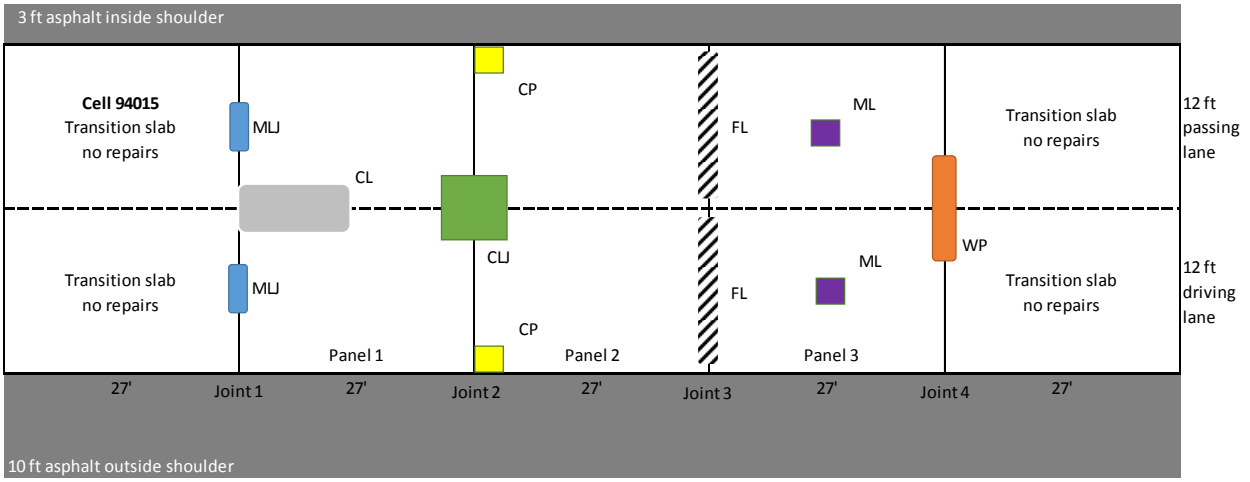

Figure 5.34 Patch Layout for Cell 94015 – Hot Mix Asphalt

The Hot Mix Asphalt was provided by District 3 and installed by MnROAD personnel. All patches were tack coated prior to mix placement. Compaction was achieved utilizing a small drum roller.

During the first-year review, the HMA patches had developed minor cracks along the edges of the patches and were in generally good condition. Figure 5.35 shows the general condition of the HMA patches in cells 94014 and 94015.

Figure 5.35 Cell 94015 – General Patch Condition for Cells 94014 and 94015

APPENDIX A
INSTALLATION PHOTOS

Photograph: Milled Patch

Subject: General patch condition after milling

Photograph: Air Blasting

Subject: Process of air blasting removing rubble

Photograph: Air Blasted Patch

Subject: General patch condition after air blasting

Photograph #: Sand Blasting

Subject: Process of sand blasting (performed after air blasting)

Photograph: Sand Blasted Patch

Subject: General patch condition after sand blasting

Photograph: 94001 CTS, Rapid Set

Subject: Mix Consistency

Photograph: 94001 CTS, Rapid Set

Subject: Placing mixture

Photograph: 94001 CTS, Rapid Set

Subject: Weighing down foam board

Photograph: 94002 SpecChem, Repcon 928

Subject: Finished Product

Photograph: 94003 (A) Western Material and Design, FasTrac246

Subject: Mixer

Photograph: 94003 (A) Western Material and Design, FasTrac246

Subject Inside of mixer

Photograph: 94003 (A) Western Material and Design, FasTrac246

Subject: Concrete placement

Photograph: 94003 (B) Western Material and Design, CE700 HPC

Subject: Heating materials prior to placement

Photograph: 94003 (B) Western Material and Design, CE700 HPC

Subject: Part A and Part B mixing

Photograph: 94003 (B) Western Material and Design, CE700 HPC

Subject: Material Placement

Photograph: 94004 D.S. Brown, PaveSaver Polymeric Concrete

Subject: Part A and Part B mixing

Photograph: 94004 D.S. Brown, PaveSaver Polymeric Concrete

Subject: Finishing material

Photograph: 94005 Willamette Valley Company, FastPatch

Subject: Finishing Product

Photograph: 94005 Willamette Valley Company, FastPatch

Subject: Final product (right side has aggregate broad cast)

Photograph: 94006 (A) Five Star, Rapid Surface Repair Easy Mix

Subject: First lift had set up

Photograph: 94006 (B) Five Star, Rapid Surface Repair Epoxy Fix

Subject: Dispensing material

Photograph: 94006 (B) Five Star, Rapid Surface Repair Epoxy Fix

Subject: Broad casting aggregate onto surface

Photograph: 94006 (B) Five Star, Rapid Surface Repair Epoxy Fix

Subject: Small application of previous patch

Photograph: 94007 TCC Materials, ProSpec Concrete Patch

Subject: Paddle Mixer

Photograph 94007 TCC Materials, ProSpec Concrete Patch

Subject Material being placed

Photograph: 94008 (B) Aqua Patch Road Materials, Aqua Patch

Subject: Patch Material the day after placement

Photograph: 94009 Crafco HP Concrete Cold Patch

Subject: Spreading Material

Photograph: 94009 Crafco HP Concrete Cold Patch

Subject: Patch material the day after placement (no traffic)

Photograph: 94010 Crafco Techcrete-TBR

Subject: Crafco Patcher (melter and mixer)

Photograph: 94010 Crafco Techcrete-TBR

Subject: Finishing tool heater

Photograph: 94010 Crafco Techcrete-TBR

Subject: Primed Patch

Photograph: 94010 Crafco Techcrete-TBR

Subject: Placed patch material

Photograph: 94010 Crafco Techcrete-TBR

Subject: Finishing patch material

Photograph: 94011 3U18M

Subject: Placing and finishing material

Photograph: 94012 USG Ecofix

Subject: Material mixing in revolving drum

Photograph: 94013 CTS, Rapid Set and Helix Fiber

Subject: Fibers and aggregate mixing

Photograph: 94013 CTS, Rapid Set and Helix Fiber

Subject: Mixing of bagged product, aggregate, and fibers

Photograph: 94013 CTS, Rapid Set and Helix Fiber

Subject: Finishing of product with steel fibers

APPENDIX B
FIRST-YEAR REVIEW PATCH CONDITONS

Cell/Patch:	94001/CLJ	Material: CTS, Rapid Set DOT Repair Mix
Date:	6/20/2018	
Condition:	Linear Cracks	
Rating:	3	

Cell/Patch:	94001/FL	Material: CTS, Rapid Set DOT Repair Mix
Date:	6/20/2018	
Condition:	Shrinkage Cracks	
Rating:	4	

Cell/Patch:	94002 (A)/CLJ	Material: SpecChem, RepCon 928
Date:	6/20/2018	
Condition:	Linear Cracks	
Rating:	3	

Cell/Patch:	94002 (A)/WP – driving lane	Material: SpecChem, RepCon 928
Date:	6/20/2018	
Condition:	Linear Cracks	
Rating:	3	

Cell/Patch:	94006 (A)/MLJ – driving lane	Material: Rapid Surface Repair Easy Mix
Date:	6/20/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94006 (A)/WP – driving lane	Material: Rapid Surface Repair Easy Mix
Date:	6/20/2018	
Condition:	Missing material along edge, less than 50%	
Rating:	2	

Cell/Patch:	94006 (A)/ WP – driving lane	Material: Rapid Surface Repair Easy Mix
Date:	9/15/2018	
Condition:	About 50% of patch was repaired.	
Rating:	1	

Cell/Patch:	94006 (B)/FL – driving lane	Material: Rapid Surface Repair Epoxy Fix
Date:	9/15/2018	
Condition:	Most of patch has been repaired.	
Rating:	1	

Cell/Patch:	94006 (B)/FL – passing lane	Material: Rapid Surface Repair Epoxy Fix
Date:	9/15/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94006 (B)/MLJ – passing lane	Material: Rapid Surface Repair Epoxy Fix
Date:	9/15/2018	
Condition:	50% of the patch is gone, needs repair	
Rating:	1	

Cell/Patch:	94006 (B)/WP	Material: Rapid Surface Repair Epoxy Fix
Date:	9/15/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94007/CLJ	Material: TCC Materials, ProSpec
Date:	6/20/2018	Concrete Patching Mix
Condition:	No distress	
Rating:	4	

Cell/Patch:	94007/FL – passing lane	Material: TCC Materials, ProSpec
Date:	6/20/2018	Concrete Patching Mix
Condition:	Less than 50% of material missing, needs repair	
Rating:	2	

Cell/Patch:	94007/FL – passing lane	Material: TCC Materials, ProSpec
Date:	9/15/2018	Concrete Patching Mix
Condition:	Less than 50% of patch repaired	
Rating:	2	

Cell/Patch:	94007/ML	Material: TCC Materials, ProSpec
Date:	6/20/2019	Concrete Patching Mix
Condition:	Less than 50% of material missing, needs repair	
Rating:	2	

Cell/Patch:	94007/MLJ	Material: TCC Materials, ProSpec
Date:	9/15/2018	Concrete Patching Mix
Condition:	Less than 50% of material missing, needs repair	
Rating:	2	

Cell/Patch:	94007/WP	Material: TCC Materials, ProSpec
Date:	6/20/2018	Concrete Patching Mix
Condition:	Less than 50% of material missing, needs repair	
Rating:	2	

Cell/Patch:	94007/WP	Material: TCC Materials, ProSpec
Date:	9/15/2018	Concrete Patching Mix
Condition:	Less than 50% of patch repaired	
Rating:	2	

Cell/Patch:	94008 (A)/ML – passing lane	Material: Aqua Patch Road Materials, Aqua Patch
Date:	6/20/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94008 (A)/MLJ – passing lane, CL, and MLJ – driving lane	Material: Aqua Patch Road Materials, Aqua Patch
Date:	6/20/2018	
Condition:	Linear cracks along joints, some edge material missing (less than 50%)	
Rating:	2	

Cell/Patch:	94008 (A)/MLJ – passing lane	Material: Aqua Patch Road Materials, Aqua Patch
Date:	9/15/2018	
Condition:	100% of patch repaired, patch failed	
Rating:	0	

Cell/Patch:	94008 (A)/MLJ – driving lane	Material: Aqua Patch Road Materials, Aqua Patch
Date:	9/15/2018	
Condition:	Linear cracks and missing material (less than 50%)	
Rating:	2	

Cell/Patch:	94008 (A)/CP – driving lane	Material: Aqua Patch Road Materials, Aqua Patch
Date:	9/15/2018	
Condition:	100% of patch repaired, patch failed	
Rating:	0	

Cell/Patch:	94008 (A)/WP	Material: Aqua Patch Road Materials, Aqua Patch
Date:	6/20/2018	
Condition:	Linear cracks and missing material along edges (less than 50%)	
Rating:	2	

Cell/Patch:	94008 (A)/WP	Material: Aqua Patch Road Materials, Aqua Patch
Date:	9/15/2018	
Condition:	Linear cracks and missing material along edges (less than 50%)	
Rating:	2	

Cell/Patch:	94008 (B)/FL – passing lane	Material: TCC Materials, ProSpec Concrete Patching Mix
Date:	9/15/2018	
Condition:	Less than 50% of patch repaired	
Rating:	2	

Cell/Patch:	94009/FL – both lanes	Material: Crafco, HP Concrete Cold Patch
Date:	9/15/2018	
Condition:	No distress, layer of material added to driving lane FL due to depression	
Rating:	4	

Cell/Patch:	94010/CLJ	Material: Crafco, Techrete-TBR
Date:	6/20/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94010/WP	Material: Crafco, Techrete-TBR
Date:	6/20/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94011/CLJ	Material: TCC Materials, 3U18 Modified
Date:	6/20/2018	
Condition:	No distress	
Rating:	4	

Cell/Patch:	94011/WP	Material: TCC Materials, 3U18 Modified
Date:	6/20/2018	
Condition:	No distress, shrinkage cracks developing	
Rating:	4	

Cell/Patch:	94012/CLJ	Material: USG Ecofix
Date:	6/20/2018	
Condition:	Corner break and cracks	
Rating:	3	

Cell/Patch:	94013 (A)/WP	Material: CTS, Rapid Set DOT Repair Mix and Helix 5-25-Standard BA (Zinc Coated) Fibers
Date:	6/20/2018	
Condition:	Crack along edge of patch	
Rating:	3	

Cell/Patch:	94013 (B)/CLJ	Material: CTS, Rapid Set DOT Repair Mix and Helix 5-25-SS BA (Stainless Steel) Fibers
Date:	6/20/2018	
Condition:	Crack near edge of patch	
Rating:	3	

Cell/Patch:	94014/WP	Material: Hot Mix Asphalt
Date:	6/20/2018	
Condition:	Edge cracks and some missing material at edges	
Rating:	NA/Not failed	

Cell/Patch:	94015/CLJ	Material: Hot Mix Asphalt
Date:	6/20/2018	
Condition:	Linear cracks at joints	
Rating:	NA/Not failed	

Cell/Patch:	94015/MLJ	Material: Hot Mix Asphalt
Date:	6/20/2018	
Condition:	Linear cracks	
Rating:	NA/Not failed	

APPENDIX C
MATERIAL TECHNICAL DATA SHEETS