November 2020

Illinois Tollway Guidelines for Pavement Assets

ILLINOIS STATE TOLL HIGHWAY AUTHORITY

Illinois Tollway

TABLE OF CONTENTS

SECTION 1.0 INTRODUCTION

The guidelines included in this document are described briefly below.

1.1 Repair of Jointed Concrete Pavement

This guideline provides details for determining the most appropriate pavement repair method for Tollway jointed plain concrete (JPC) pavements based on visual condition. As a part of pavement rehabilitation, repairs often must be made to the existing JPC pavements to improve the condition of the original pavement prior to placement of an asphalt overlay or concrete pavement restoration (CPR). Repairs must be selected carefully to ensure that the final pavement surface is smooth, strong, and durable. Selection of the proper repair method provides a cost-effective, high-quality roadway.

This document is not intended to provide guidance on the reconstruction of JPC pavements.

1.2 Repair of Continuously Reinforced Concrete Pavement

This guideline provides details for determining the most appropriate pavement repair method for Tollway CRC pavements based on visual condition. As a part of pavement rehabilitation, repairs often must be made to the existing CRC pavements to improve the condition of the original pavement prior to placement of an asphalt overlay or concrete pavement restoration (CPR). Appropriate selection of CRCP repair types and strategies for both the PCC and the reinforcing steel will ensure that the pavement surface is maintained in the manner most likely to result in an efficient, cost-effective, smooth surface for users of the Tollway.

This document is not intended to provide guidance on the reconstruction of CRC pavements.

1.3 Material Transfer Device (MTD) Usage

MTDs are required when placing full-depth Warm Mix Asphalt (WMA) and overlays of existing concrete. The MTDs ensure that the asphalt binder and surface layers do not experience segregation as they are placed along the mainline pavement and adjacent full-depth asphalt shoulders. The MTD also provides a steady flow of material to the paver and may be used to facilitate placement of other mixtures. By keeping the speed of the paver and the head of material constant, the MTD contributes to improved pavement smoothness.

The Tollway Special Provision for MTDs allows a device to be used on a concrete pavement with restrictions with respect to the type of equipment, location relative to the edge of pavement and strength of the pavement.

These guidelines have been developed to provide a reference should other types of MTDs be proposed for conditions beyond those referenced in the Tollway SP for Material Transfer Devices. Requests for allowance of other MTDs should be submitted via the Tollway's WBPM system (e-Builder) with as many details as possible to allow for the most accurate analysis possible.

The following guidelines are planned and will be added to this document as they become available.

1.4 Repair of Full-depth Asphalt Pavement (Mainline and Shoulders)

This guideline provides details for determining the most appropriate pavement repair method for Tollway full-depth hot mix asphalt (FDHMA) pavements based on visual condition. As a part of pavement rehabilitation, repairs often must be made to the existing FDHMA to improve the condition of the original pavement prior to placement of an asphalt overlay. Appropriate selection of FDHMA repair types and strategies will ensure that the pavement surface is maintained in the manner most likely to result in an efficient, cost-effective, smooth surface for users of the Tollway.

This document is not intended to provide guidance on the reconstruction of FDHMA pavements.

1.5 Repair of Composite Pavement

This guideline provides details for determining the most appropriate pavement repair method for Tollway composite pavements based on visual condition. As a part of pavement rehabilitation, repairs often must be made to the existing composite pavements to improve the condition of the original pavement prior to placement of an asphalt overlay. Appropriate selection of repair types and strategies for both the underlying PCC and the surface layer HMA pavement components will ensure that the pavement surface is maintained in the manner most likely to result in an efficient, cost-effective, smooth surface for users of the Tollway.

This document is not intended to provide guidance on the reconstruction of composite pavements.

1.6 Repair and Maintenance of Tollway Ramp Pavements

This guideline provides details for determining the most appropriate pavement repair method for Tollway ramp pavements based on visual condition. Appropriate selection of ramp repair types and strategies for PCC, FDHMA, or composite ramp pavements and the maintenance-of-traffic (MOT) requirements for each ramp, will ensure that the pavement surface is maintained in the manner most likely to result in an efficient, cost-effective, smooth surface for users of the Tollway.

This document is not intended to provide guidance on the reconstruction of Tollway ramp pavements.

1.7 Repair and Maintenance of Toll Plaza Pavements

This guideline provides details for determining the most appropriate pavement repair method for Tollway toll plaza pavements based on visual condition. Appropriate selection of plaza pavement repair types and strategies for PCC pavement and consideration of the maintenance-of-traffic (MOT) requirements for each toll plaza lane, will ensure that the pavement surface is maintained in the manner most likely to result in an efficient, cost-effective, smooth surface for users of the Tollway.

This document is not intended to provide guidance on the reconstruction of toll plaza pavements.

1.8 Repair and Maintenance of Tollway Maintenance Yard Pavements

This guideline provides details for determining the most appropriate pavement repair method for Tollway maintenance yard pavements based on visual condition. Appropriate selection of repair types and strategies for maintenance yard pavements will ensure that the pavement surface is maintained in the manner most likely to result in an efficient, cost-effective, smooth surface for Tollway maintenance staff and vehicles.

This document is not intended to provide guidance on the reconstruction of Tollway maintenance yard pavements.

1.9 Evaluation and Management of Tollway Pavements

For the past 20 years, Tollway pavements have been evaluated annually to determine the Condition Rating System (CRS) for all segments. Monitoring CRS values, as well as the International Roughness Index (IRI) and remaining service life (RSL), has allowed the Tollway to better predict long-term pavement rehabilitation and reconstruction needs. The Tollway Pavement Asset Master Plan (PAMP) contains long-term plans for up to 75-80 years long documenting the major maintenance, rehabilitation, and reconstruction activities for all mainline pavements.

Tollway ramp pavements are also evaluated every three years, with the same performance indicators (CRS, IRI, and RSL) monitored in the same manner as mainline pavements. Beginning in 2018, the condition and predicted future performance of all Tollway ramp pavements were collected in a comprehensive Ramp Asset Master Plan (RAMP) for the first time. Regular updates to the RAMP moving forward will better help the Tollway with long-range planning for maintenance, rehabilitation, and reconstruction of Tollway ramp pavements in the same manner as the mainline pavements.

This document provides details on how Tollway pavements – both mainline and ramps – are evaluated, rated, and managed as part of the Tollway's overall asset management effort.

SECTION 2.0 GUIDELINES FOR REPAIR OF JOINTED CONCRETE PAVEMENT

2.1 Introduction

The objective of this guide is to provide the Illinois Tollway with a method for determining the most appropriate pavement repair method for jointed concrete pavements based on visual condition. As a part of pavement rehabilitation, repairs often must be made to the existing jointed plain concrete pavement (JPCP) to improve the condition of the pavement prior to placement of an asphalt overlay or concrete pavement restoration (CPR). These repairs must be selected carefully to ensure that the final pavement surface is smooth, strong, and durable. Selection of the proper repair method provides a cost-effective, high-quality roadway.

There are a wide range of repair methods available, but for large-scale projects it is wise to limit the number of methods to be used. This allows the engineers and contractors to become experts in the methods they use, rather than simply being familiar with a vast array of methods. For the purpose of this guide, a limited, familiar set of methods is specified. As more methods are utilized on specific projects, they may be added later.

This guide suggests particular methods of repair. However, to say that for each situation there is a corresponding correct treatment would be misleading. Inevitably, there will be unique situations—"grey areas"—where the rules don't point to a single technique. In many situations, several repair techniques can yield successful repairs that will last many years. The final selection of repair treatments should consider not only the physical, engineering properties of the existing road and possible repair treatments, but also the construction costs, time constraints, and availability of materials and qualified contractors.

This guide does not provide detailed specifications or instructions for performing repairs. It is assumed that proper specifications and techniques will be used. Above all, it is critical that proper construction practices are used, regardless of which repair technique is used.

2.2 Pavement Evaluation

The first step in determining the proper repair technique for a pavement is to ascertain the pavement's current condition. For the purpose of this guide, we will assume that each slab is evaluated individually. However, it should be noted that several consecutive slabs with the same problem may require a different repair technique.

An evaluation of the existing pavement condition is necessary to determine whether certain repair options, though feasible, are truly the best option. Though one may find hairline, mid-slab cracks in some locations that seem perfect for dowel bar retrofit, further evaluation of the pavement may reveal that the overall condition of the pavement makes such a repair less desirable because the entire pavement may need to be reconstructed.

To determine the pavement condition, a visual distress survey is required. Each crack within the slab should be documented by assigning a severity level as well as its location with respect to the joints. The evaluator should note whether the cracking is transverse, longitudinal, or other, and categorize it as low, medium, or high severity.

2.2.1 Crack Types

Transverse cracks are predominantly perpendicular to the pavement centerline, and longitudinal cracks are predominantly parallel to the pavement centerline. Other types of cracking include corner breaks, which intersect the adjacent transverse and longitudinal joints at an angle about 45° to the direction of traffic, and durability ("D") cracking, which refers to closely spaced crescent-shaped hairline cracks that occur adjacent to joints, cracks, or free edges. Figure 1 shows examples of the various crack types, and Figure 2 shows examples of the various crack cross sections.

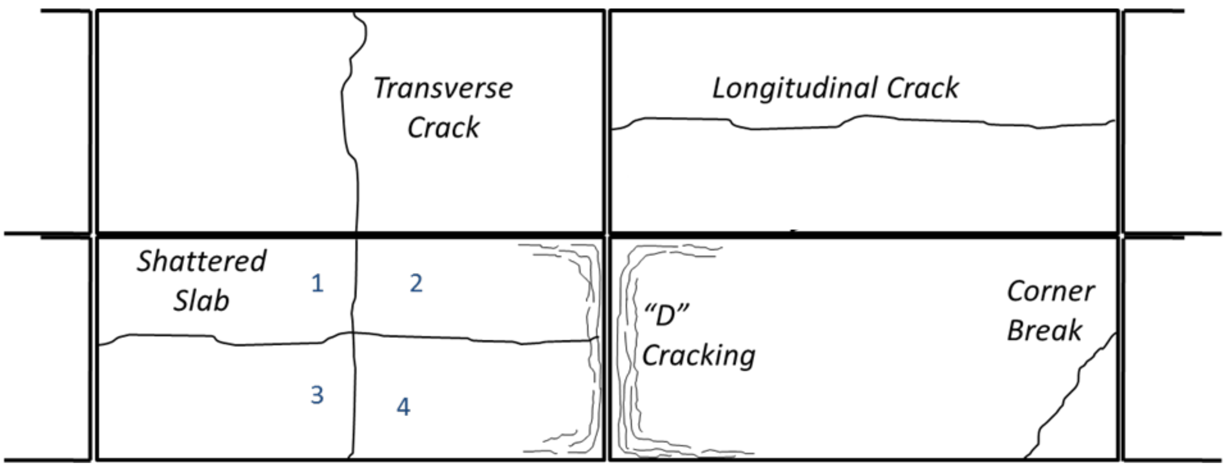


Figure 1. Examples of various crack types.

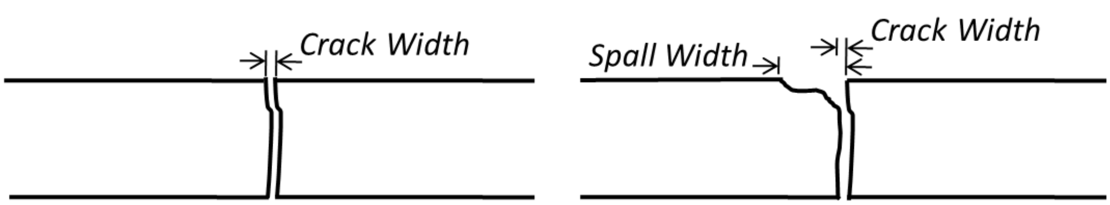


Figure 2. Example of various crack cross sections, including spalling.

2.2.2 Crack Severity

Crack severity is based on the width of the crack, the spalling of the crack, and any associated faulting. Specific descriptions are provided below:

- **Low Severity:** Width less than 1/8 in, less than 10 percent of the length of the crack has spalling, and no measurable faulting.
- **Moderate Severity:** Crack width less than ½ in, spalling width less than 3 in at any point along the crack, and/or faulting less than ½ in.

- **High Severity:** Crack with greater than ½ in, spalling greater than 3 in at any point along the crack, and/or faulting greater than ½ in.

Figures 3 through 6 are photographs of low-, moderate-, and high-severity transverse cracks in JPCP. Slabs that are broken into four or more pieces are considered shattered slabs.

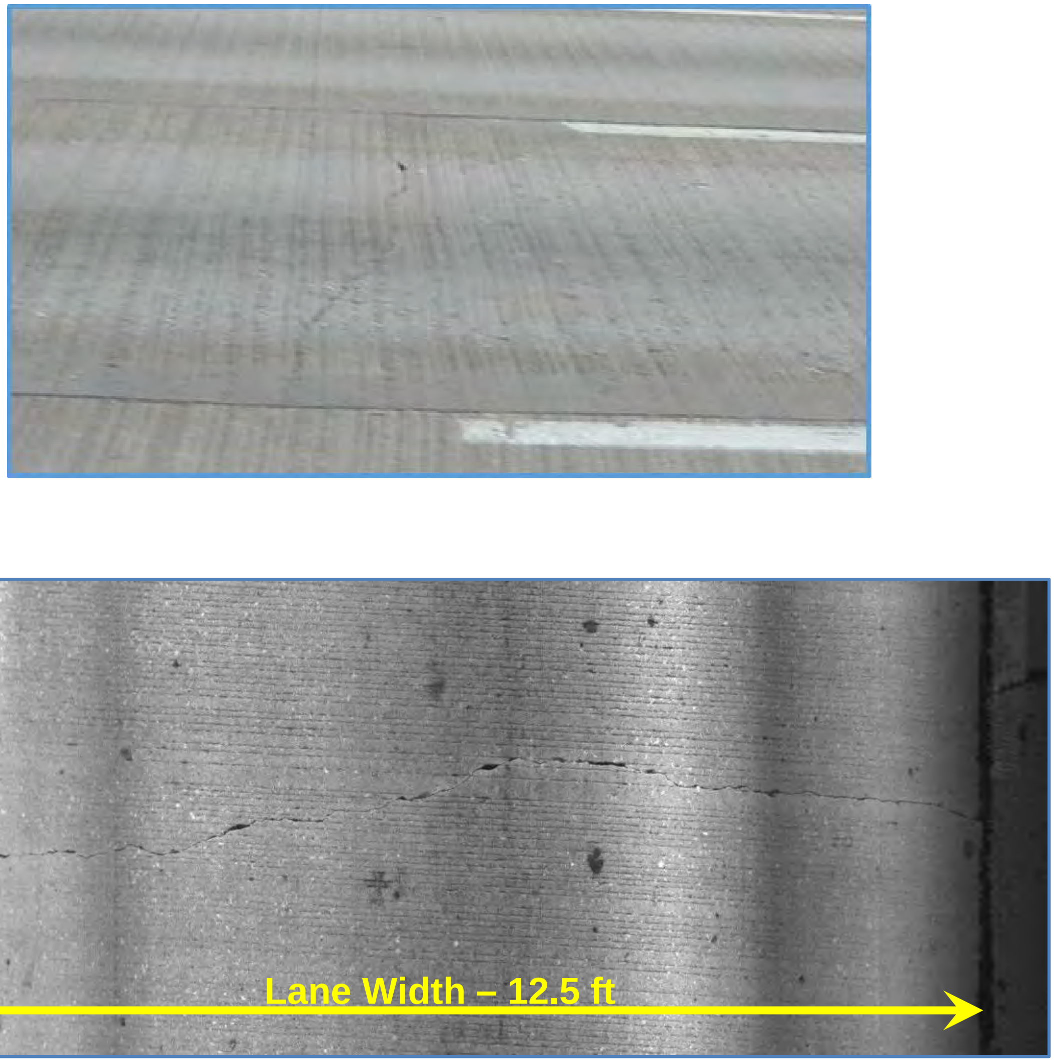


Figure 3. Low-severity transverse crack (full lane width).

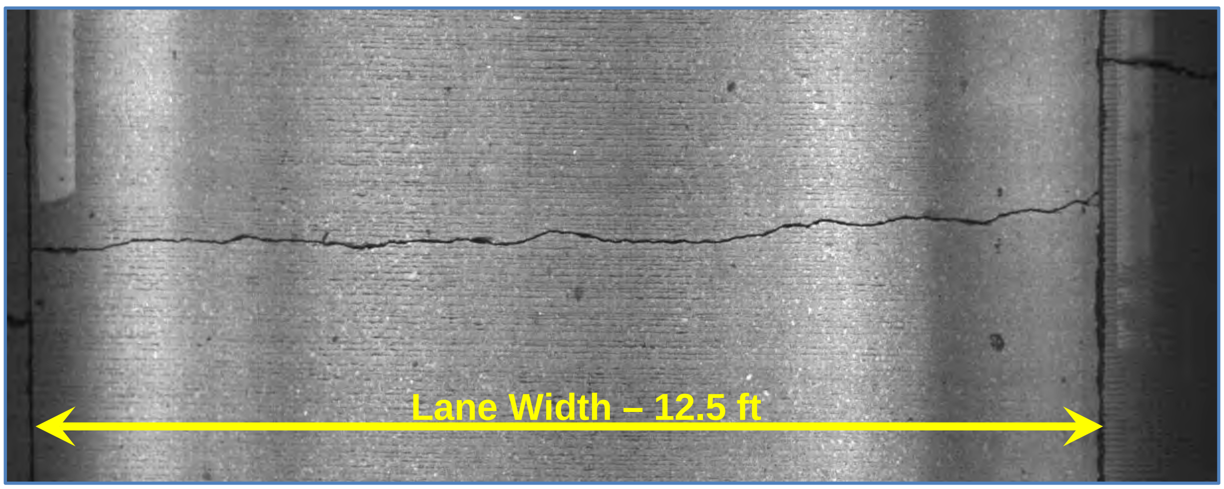


Figure 4. Moderate-severity transverse crack (full lane width).

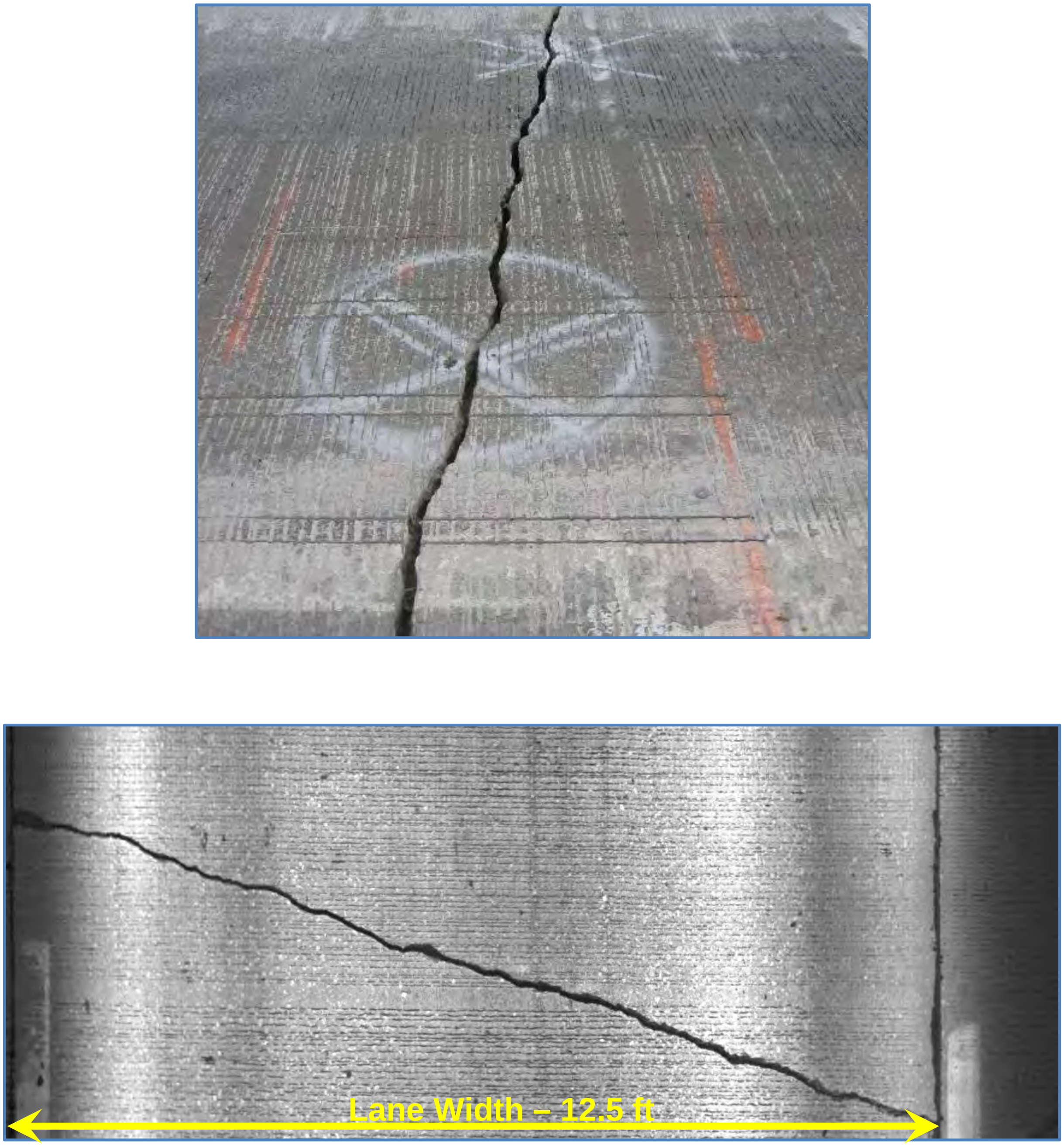


Figure 5. High-severity transverse crack (full lane width).

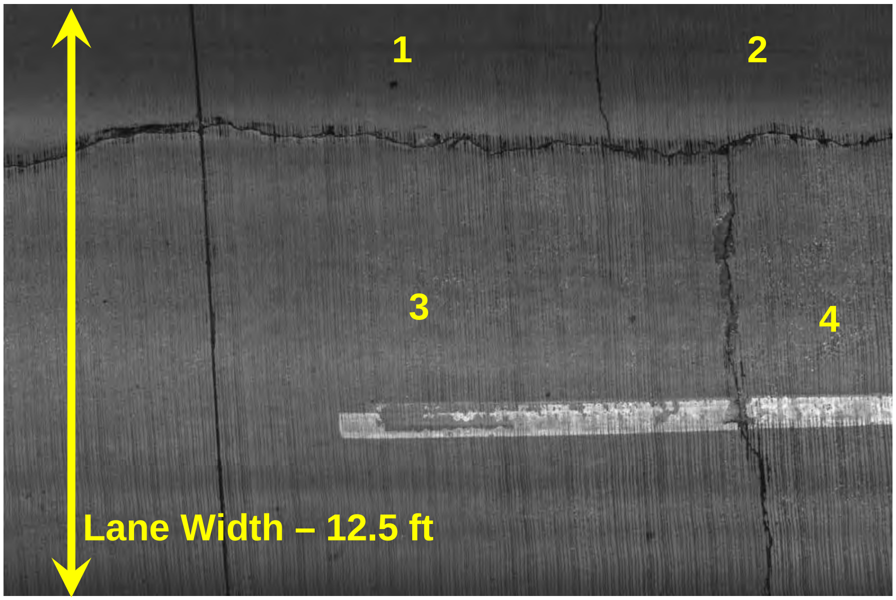


Figure 6. Shattered slab.

In some cases, nondestructive testing (NDT) may be needed to determine the condition of the underlying base layer to make sure that JPCP repair techniques are appropriate. Additionally, cores may be needed if thickness information is unknown or questionable.

2.2.3 Surficial Distress

In addition to cracking, there could be isolated surficial distress in the concrete pavement. The distress is typically seen adjacent to expansion joints (Figure 7) and at locations of damaged lane markers (Figure 8). This type of distress is not considered to have a significant effect on the structural integrity of the pavement, but it will affect ride quality.

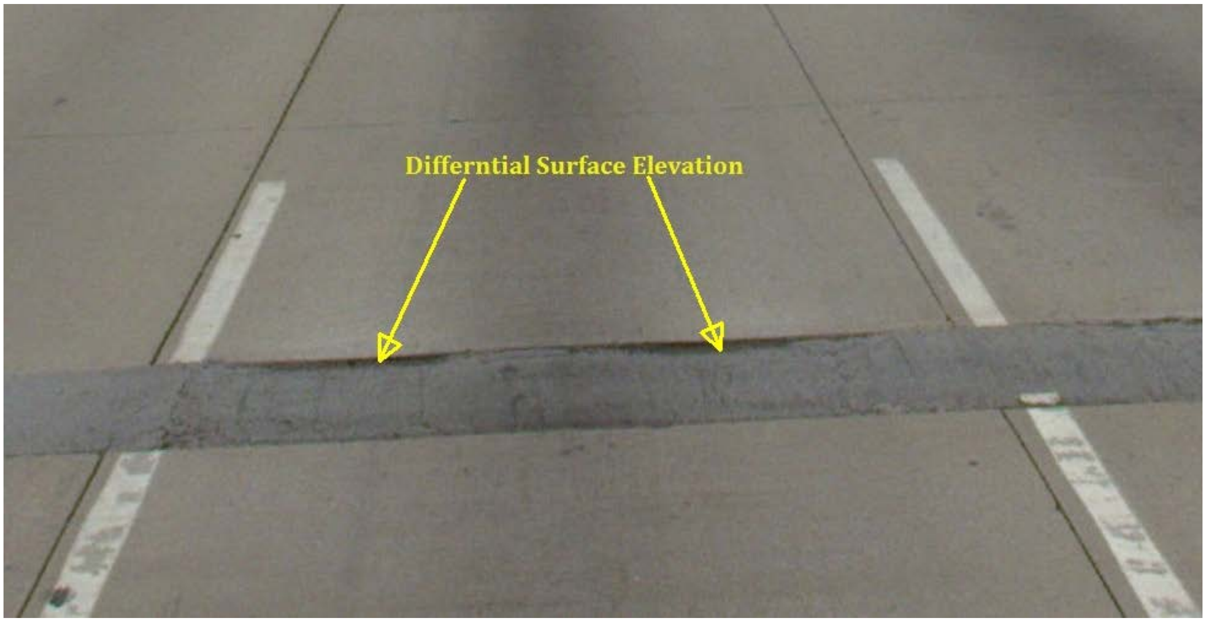


Figure 7. Surficial distress adjacent to expansion joint.

Figure 8. Damages lane mark by pavement distresses.

2.2.4 Repair Methodology

Once the pavement condition is known, the density and location of the cracking should be examined by, or reviewed with, Tollway Engineering. The best repair technique for a slab may be affected by the specific location and density of the cracks in a particular area. However, all factors that could affect the repair should be considered in each area. In some instances, the most appropriate repair method may have more to do with constructability.

Evaluation of the repair technique does not stop once a treatment has been specified. It is also necessary to monitor the repair projects as they are performed. New information may come to light while the construction work is underway that would require the method or extent of repairs to be modified. An example of this is base repair under a slab repair. Once the concrete is removed, extensive base failure may be encountered. Potential base restoration or repair methods will need to be specified and executed immediately. It is even possible that the repair will need to be cut back further to expose additional base area for excavation, infill, and compaction prior to placement of the patch, or pressure injection of expanding polymer may be required under adjoining pavement slabs after patching to stabilize the surrounding base. Proper engineering oversight of JPCP repairs is essential to ensure a high-quality final product.

2.3 Repair Technique Selection

While there are many repair methods and variations on those methods, the list of Tollway recommended repair strategies in this document is limited to those in common use and known to have good pavement performance. Table 1 summarizes repair types and their expected service life.

Table 1. Repair types and expected service life.

Repair Type	Expected Service Life (years)
Dowel Bar Retrofit (in 20-ft joint spacing)	5 - 15
Surficial Partial Depth Patch	5 - 10
Surficial Partial Depth Pavement Spot Patching	Similar to adjacent pavement
Diamond Grinding (small segments)	5 - 8
Diamond Grinding (large area)	7 - 10
Dowel Bar Retrofit (in 15-ft joint spacing)	10 - 15
Full Depth Patch (Accelerated, Precast or Standard)	10 - 20
Slab Replacement (Accelerated, Precast or Standard)	10 - 20
Slab Jacking/Undersealing	10 - 20

The appropriate repair should be selected carefully, based on all available information. Alternate methods not discussed in this guide may be used. In these cases, as with all repairs, it is necessary to ensure that the selected repair method mitigates the visible cracking and addresses the cause of the cracking.

2.3.1 Load Transfer Restoration (Dowel Bar Retrofit)

Load transfer restoration should be performed per the Tollway special provision for dowel bar retrofit, which is provided in Section 1.4. Load transfer restoration is appropriate in the following conditions:

- Low- to moderate-severity transverse cracks located away from joint
- No signs of base distress
- No significant faulting

Load transfer is the ability of a joint (or crack) to transfer a portion of an applied wheel load from one side of the joint/crack to the other side. Joint load transfer can be achieved by a combination of aggregate interlock, mechanical transfer devices (such as dowel bars), and a stable base.

When a slab cracks, the slab effectively acts as two separate slabs. In a jointed plain concrete slab, the sources of load transfer across cracks are aggregate interlock and the base course support. As a crack deteriorates, load transfer from aggregate interlock decreases, eventually leaving only the load transfer provided by the base course.

Load transfer is just as important across a crack as it is across a joint. In the early stages of a crack's life, the aggregate interlock will transfer the load across the crack, and restoring load transfer using such methods as dowel bar retrofit can assure that load transfer doesn't degrade as the crack opens up. If mitigation is applied while there is still some aggregate interlock across the crack, then significant cost savings can be realized by using load transfer restoration.

Whether by dowel bar retrofit or by other means, for load transfer restoration to be cost-effective the pavement must meet several criteria:

- The pavement should have a considerable remaining service life and structurally adequate slab thickness.
- The surrounding concrete must be otherwise sound. If the surrounding concrete or base is not sound, the removal and replacement methods along with appropriate base restoration procedures must be used. Otherwise, continued deterioration of the area will negate any benefits of load transfer restoration.
- Areas with faulting in excess of ¼ inches should not be considered for load transfer restoration. In this case, remove and replace methods should be used to allow investigation of the base during repair.
- Load transfer restoration should be considered primarily for low- to moderate-severity cracks that are located away from the joints of the slab (not within 4 ft of the joint).
- Load transfer restoration should not be considered if there is evidence of possible underlying base problems.
- Any transverse crack that is exhibiting a medium-to-high level of spalling (even if the crack is tight) should be repaired with full-depth concrete to ensure that the "working" of the crack has not compromised the base material.
- Any signs of pumping (discharge of base or subgrade material from the crack) should preclude the site from consideration for load transfer restoration. Full-depth pavement repair or full slab replacement must be used so that the base can be exposed and repaired as necessary.

As discussed previously, a crack in a slab will act in much the same way as a joint. Repairing the crack by load transfer restoration enhances this behavior. It is crucial to ensure that the dowel bars are placed with proper alignment, greased, and capped so that that this new "joint" does not lock up and cause additional cracking at a later time. Greasing or lubricating allow dowel bars longitudinal movement in the concrete. End caps provide a gap between dowel bar and concrete to accommodate volume changes in concrete occurs due to moisture and temperature.

Care should be taken during construction of dowel bar retrofits to ensure that the proper grout is used and that the crack channels are sealed after cutting to prevent grout from flowing away from the dowels as specified in the attached special provision. Once load transfer restoration has been completed, the new "joint" should be inspected. If the grouting material is left high in the slots, diamond grinding or other suitable methods should be used to improve ride quality over the repair site. Once the dowel bar retrofit operation is complete, the remainder of the crack should be filled with crack filler in accordance with Tollway specifications to prevent water and debris from entering.

2.3.2 Surficial Partial-Depth Pavement Spot Patching

Partial depth repair restores localized surface distresses, which do not extend beyond half of the pavement thickness in depth. This repair consists of partial depth patching at spot locations of isolated surficial pavement distress of an area or spalling that exceeds 4 inches in both width and length; does not exceed 18 inches in any one direction, and is greater than 2 inches in depth at any point within the area but not greater than half the pavement thickness in depth. The distress is typically seen adjacent to expansion or construction joints (spalls and corner breaks) and at locations of a removed or delaminated Raised Pavement Lane Marker (RPM). This work does not apply to extended length repairs of spalled joints, only to spot repairs within the specified limits for size.

2.3.3 Slab Repair (Full-Depth or Surficial Partial-Depth Repair)

Slab repairs should conform to Illinois Department of Transportation (IDOT) and/or Tollway standards. Standard cast-in-place concrete repair procedures should be in accordance with Section 442 of the IDOT Standards for Class B Patches. Precast concrete repairs should be in accordance with the Tollway special provisions for precast replacement of concrete pavements. Accelerated cast-in-place concrete repair procedures should be in accordance with the Tollway special provisions for accelerated concrete pavement repair. Slab repair is appropriate in the following conditions:

- Moderate- to high-severity transverse cracking.
- Effective repair area is significantly less than slab size.
- Effective distance between repairs is sufficient to allow efficient construction staging.

If load transfer restoration is not an option for any reason, slab repair should be considered.

Pavement slab repairs cannot be used to restore or repair an existing pavement joint. If the repair limit falls within 3 ft of an existing pavement joint, the repair should be extended beyond the pavement joint by 1 ft, thereby replacing the existing pavement joint. This condition generally exists when the crack location is within 6 ft of an existing joint. Figure 9 shows an example of a crack whose repair should include replacement of the joint. All repairs should extend the full width of the slab(s).

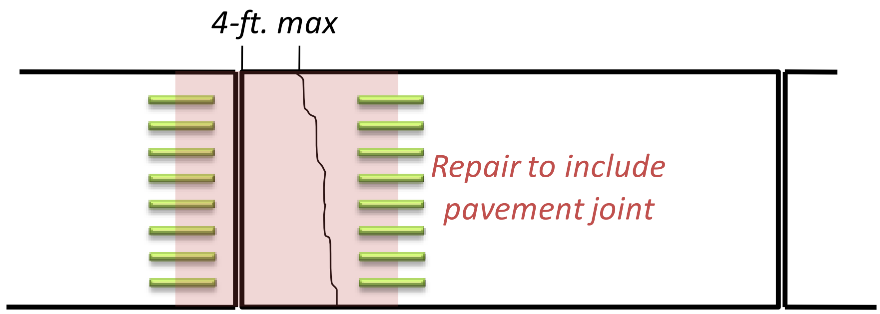


Figure 9. Crack requiring joint replacement.

Partial-depth repairs need to be considered if slab deterioration is located primarily in the upper one-third to upper one-half of the slab and the existing load transfer mechanisms are still functional.

Pavement distress that can be successfully corrected by using partial-depth repair includes:

- Spalling generated by the intrusion of incompressible materials into the joints.
- Spalling caused by poor compaction, inadequate curing, or improper finishing.
- Spalling caused by weak concrete and reinforcing steel located too close to the surface or at locations where pavement markers have debonded from the concrete.

Concrete pavement distresses that are not candidates for partial-depth repair include:

- Spalling because of dowel bar misalignment or lock-up.
- Spalling of transverse or longitudinal cracks generated by shrinkage, fatigue, or foundation movement.
- Spalling caused by D-cracking or reactive aggregate.

With full depth repairs, care must be taken during removal to ensure that the adjacent pavement is not damaged. Full-depth saw cuts and careful removal techniques must be used. Once the base is exposed, it should be inspected for deficiencies. Fouled aggregate base, unstable base, and other pavement base problems must be resolved prior to concrete placement. Only after the base has been repaired and prepped should placement proceed. All repairs must be doweled, tied, and placed in accordance with Tollway specifications. Care must be taken to ensure that all materials and workmanship comply with Tollway standards.

Dowel and tie bars (as specified) should be drilled and epoxied into the sawn faces of the joints to ensure stability and load transfer between the repair and the adjacent slabs. The exposed dowel bar ends should be lightly greased in accordance with specifications to avoid joint lock-up.

If the repair elevation is too high after completion of repair and curing, diamond grinding should be used to smooth out the joints. All necessary joints should be saw cut and sealed after repairs are complete and required curing has occurred.

2.3.4 Diamond Grinding

Diamond grinding may be used to alleviate faulting or other ride quality issues if it can be established that the area in question is structurally sound. These situations typically are encountered at joints or slab repairs where the material was placed with bumps, or mid-slab where grade control was not proper or in compliance with contract specifications. Diamond grinding may be used to remove small amounts of material (less than 0.5 inches) to restore ride quality without making a significant impact on overall pavement thickness. Surface variations which exceed specified tolerances shall be marked by the Engineer and removed by the Contractor with an approved grinding device consisting of multiple saw blades.

2.3.5 Full Slab Replacement

Slab replacement can be achieved by either cast-in-place methods in accordance with Section 442 of the IDOT Standards for Standard Class B Patches or in accordance with the Tollway special provision for accelerated full depth patching of concrete pavements; or precast methods in accordance with the Tollway special provision. Full slab replacement should be used when any of the following conditions exist:

- Ten or more consecutive slabs require repair.
- A slab is shattered (slab broken into four or more pieces).
- Slab repair costs exceed slab replacement costs for a given stretch of pavement.
- Any slab would, after repair, have remaining interior intact sections less than 6 ft long or remaining intact sections off transverse joints of less than 4 ft. long.

If 10 or more consecutive slabs will be repaired, full slab replacement may be a cost-effective construction method. Also, despite best efforts to achieve a smooth transition between repairs and existing pavement, some differential may exist. Placing a large number of slab repairs in a small area may result in an uneven surface and poor ride quality.

Site conditions, time constraints, and available resources may make slab repairs or full slab replacement more or less desirable. With either method, applicable standards and sound construction practices must be used at all times to ensure that the final product is acceptable and durable.

Care must be taken to ensure that the adjacent pavement is not damaged during the removal of existing concrete. Full-depth saw cuts must be used at all times. Overcuts should be cleaned and treated. Once the base is exposed, it must be examined to determine if base repairs are necessary. All base repairs must be made prior to prepping the base for placement of new concrete.

Dowel and tie bars (as specified) should be drilled and epoxied into the sawn faces of the joints to ensure stability and load transfer between the repair and the adjacent slabs. When using cast-in-place slabs, all joints should be sawed and sealed once concrete has cured. All materials and work practices must meet applicable Tollway specifications. If final patch elevations are found to be too high after completion of slab replacement, diamond grinding should be used to smooth transitions as necessary.

2.3.6 Slab Jacking/Under-sealing

Slab jacking should be performed per the Tollway special provision. Slab jacking/under-sealing is appropriate in the following conditions:

- Otherwise intact slabs are vertically misaligned (settlement).
- Base stabilization under intact slabs is required, as determined by visual observation of eroded base or analysis of Falling Weight Deflectometer (FWD) data.

Areas that exhibit excessive faulting, dipping, or other vertical slab alignment issues, but are otherwise sound and intact, can be considered for slab jacking. In slab jacking, a polyurethane, grout, or epoxy is injected under the affected slabs to raise the elevation of the slab to the desired height. Care must be taken to ensure that the desired effect is achieved and that adjacent areas are not adversely affected.

Slab jacking/under-sealing can be combined with load transfer restoration if a section has only low-severity cracks. The load transfer restoration should be performed prior to the slab jacking/under-sealing.

The effectiveness of slab jacking depends on closely monitoring the amount of lift being performed at any one location. It is very important that the slab not be lifted more than 0.25 inches at a time to prevent the development of excessive stresses in the slab.

2.4 Jointed Plain Concrete Pavement – Special Provisions

The text from the special provisions is provided in this section for convenience and may not be the most up-to-date version. Contact the Tollway for the current version of the special provisions.

2.4.1 Precast Replacement of Concrete Pavement Slabs (Illinois Tollway)

Description. This work shall consist of:

- Removal of existing concrete pavement.
- Restoration of the subbase material.
- Installation of precast concrete pavement slabs in accordance with the contract documents.
- Sealing of joints at locations designated by the Engineer, or as shown in the Plans, or described in the Special Provisions.

The precast slab system selected must be approved by the Tollway based on compliance with the Special Provision for Precast Concrete Pavement Slab Systems.

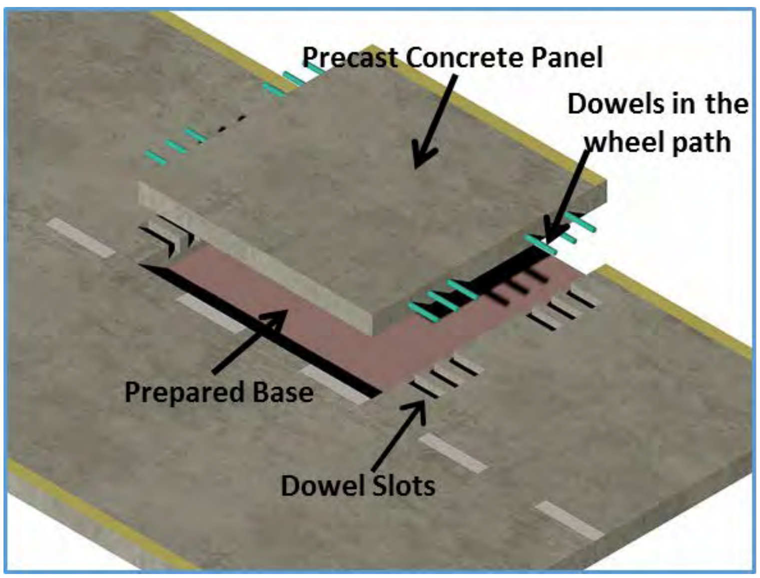


Figure 10. Schematic of precast concrete panel with dowel bars.

Materials. The materials must meet the requirements of the Special Provision for Precast Concrete Pavement Slab Systems.

Construction Requirements.

1. General. Pavement areas to be repaired will be delineated by the Engineer using spray paint furnished by the Contractor. Any areas of pavement removed and replaced outside the limits established by the Engineer shall be done entirely at the Contractor's expense. After removal of the concrete pavement, stabilized subbase, and the top 2 inches of any porous granular subbase in a repair area, the Engineer shall determine the suitability of the existing subbase

material and the steps necessary to restore the subbase in accordance with the special provision for “Aggregate for Base Course Restoration, Special.”

2. Meetings. Convene a pre-placement meeting 7 to 14 calendar days before the planned start of slab installation with the Engineer, manufacturer, supplier, system designer, and any relevant subcontractors to review and coordinate all aspects of pavement removal, placement, and inspection, including equipment and personnel requirements. Install slabs to the line and grade depicted in the contract documents ± ¼ inch.

3. Technical Assistance. Several processes in this specification are performed in accordance with the system designer’s instructions. The system designer must supply on-site technical assistance at the beginning of the installation until the Engineer determines the assistance is no longer required. Provide approved system designer instructions to the Engineer at least 30 calendar days before starting work associated with slab installation.

4. Weather Limitations. Article 420.07 of the Standard Specifications shall apply.

5. Pavement Removal. If the limits of a repair area are marked on existing contraction joints, no sawing of the existing pavement will be required.

   Equipment and methods used for removing old pavement shall be such as to prevent cracking, shattering or spalling of the pavement remaining in place. Should the remaining pavement be damaged by this operation, the Contractor shall immediately change equipment and/or methods to prevent damage to any more pavement. Care shall be exercised in the removal of the pavement to prevent damage to load transfer devices, tie bars, or adjacent concrete surfaces or edges in portions of the pavement that are to remain in place. Adjacent pavement or bars damaged as a result of the removal process shall be replaced at the Contractor’s expense to the satisfaction of the Engineer.

6. Disposal of Excavated Materials. Materials resulting from the removal of concrete pavement and materials removed for base course restoration, as required, shall be disposed of by the Contractor at his expense, in accordance with the applicable portions of Article 202.03 of the Standard Specifications.

7. Subbase Course. The subbase shall be prepared to the requirements of Special Provision “Aggregate Subgrade, 12-inch” for new construction and add-on lanes. For pavement repair over dense graded capping aggregates, any areas of a dense graded subbase that are below the required elevation of the finished subbase, due to the Contractor’s operations in breaking or removing old pavement, shall be built up to meet the level of the surrounding subbase to the satisfaction of the Engineer in accordance with the contract documents at the Contractor’s expense. For repairs over porous granular subbase, or if the Engineer determines that the existing granular subbase is unsuitable for the intended purpose, the Contractor shall remove the unsuitable material in the pavement removal areas to the depth specified by the Engineer (not less than 2 inches) and replace the material removed with an equal thickness of new material placed and compacted in accordance with the requirements of the Special Provision for “Aggregate for Base Course Restoration, Special.” Follow the system designer’s

instruction for any final subbase preparation prior to slab installation. Do not disturb the prepared surface before installation.

8. Slab Installation. Install the slabs in accordance with the system designer's instructions. Set grade-supported slabs to achieve maximum contact with the prepared subbase.

9. Joints. Submit a proposed joint layout with the Fabricator Working Drawings, submitted in accordance with the Special Provision for "Precast Concrete Pavement Slab Systems." Align joints both transversely and longitudinally between abutting precast slabs, i.e., do not stagger joints, except where approved on the joint layout. When tying precast slabs to existing concrete pavement, such as an add-on lane, joint alignment is not required. However, do not drill and anchor longitudinal joint ties within 16 inches of a transverse joint in the existing pavement.

10. Joint Widths. For pavements remaining concrete surfaced, install slabs such that joint widths are less than ½ inch, regardless of joint orientation. These dimensions apply to joints between adjacent precast slabs or joints between precast slabs and existing pavement.

11. Bed and Level Slabs. Bed and level slabs in accordance with the system designer's instructions such that the vertical differential across any joint is ¼ inch or less.

12. Backfill Pavement Hardware. Backfill around pavement hardware in accordance with the system designer's instructions.

13. Smoothness (Pavements Remaining Concrete Surface). Article 420.10 of the Standard Specifications shall apply.

14. Opening to Traffic (Grade-Supported Slabs). It is highly desirable to open precast slabs to traffic after the following:
    - The backfill material around the pavement hardware obtains 2,500 psi compressive strength.
    - The bedding and/or slab leveling materials obtain 300 psi compressive strength.
    - The joints are sealed in accordance with Article 420.12 of the Standard Specifications.

Slabs may be opened before backfill material and/or bedding grout/slurry is placed. In this case, backfill material and bedding grout/slurry must be placed within 24 hours of the first slab's placement. Remove and reset any slabs having a vertical differential greater than ¼ inch across any joint.

The longer slabs are opened to loads before backfilling and grouting, the greater the potential for slab movement. Schedule work to minimize the amount and duration of ungrouted slabs open to traffic.

15. Opening to Traffic (Grout-Supported Slabs). Open precast slabs to traffic after the following:

- The backfill material around the pavement hardware obtains 2,500 psi compressive strength.
- The bedding and/or slab leveling material obtains sufficient strength to support loads without deflection.
- The joints are sealed in accordance with Article 420.12 of the Standard Specifications.

Slabs may be opened before backfill material around the pavement hardware has been placed. In this case, backfill material must be placed within 24 hours of the first slab's placement. Remove and reset any slabs having a vertical differential greater than ¼ inch across any joint.

The longer slabs are opened to loads before backfilling, the greater the potential for slab movement. Schedule work to minimize the amount and duration of ungrouted slabs open to traffic.

Method of Measurement. PRECAST REPLACEMENT OF CONCRETE PAVEMENT SLABS will be measured for payment in square feet of the area of slab delivered and placed, and accepted in accordance with the Contract.

Reinforcement and other such items incidental and necessary to provide complete assemblies, as shown on the Plans, will not be measured separately for payment.

Basis of Payment. Payment for PRECAST REPLACEMENT OF CONCRETE PAVEMENT SLABS, measured as specified above, will be made at the Contract unit price per square foot, which payment shall constitute full compensation for saw cutting and removal of existing pavement, disposal of excavated materials, furnishing all materials required for the slab, including concrete, reinforcement, inserts, and other embedded metalwork; for delivering the slab to the designated sites; for unloading, erection, and placement into the pavement including all labor, equipment, tools, and other incidental necessary to complete this item as specified, including technical assistance from the system designer.

The cost of work and material involved to perform any necessary restoration to the existing subbase shall be included in the contract unit price bid for AGGREGATE FOR BASE COURSE RESTORATION, SPECIAL.

2.4.2 Slab Jacking, Special (Illinois Tollway)

Description. This work shall consist of the mixing and placing of high-density polyurethane slurry injected under pressure through holes cored into the existing slab or formed in the precast slab to restore the slab to its intended elevation as indicated on the plans and/or as directed by the Engineer. This work shall include drilling or forming injection holes, placing of the material, testing and surveying to control the lift of the pavement, cleanup, and other related work. Any alternate procedures for slab jacking must be submitted to the Engineer for review and approval. In the event that an alternate procedure is proposed, the Contractor must provide to the Engineer detail of the materials, equipment, and construction methods required.

Materials. The material used for raising the concrete slabs shall be high density polyurethane slurry exhibiting the following characteristics:

Density (KG/M3) ASTM D 1622 .... 33.639

Tensile Strength (KPA) ASTM D 1623 372

Elongation (%) 5.1

Compressive Strength (KPA) ASTM D 1621 (at Yield) 324

K-Factor (W/MK) 0.018

Volume Change (% of Original) 0

Equipment. A list of all lifting equipment shall be submitted to the Engineer for review and approval. A list of the minimum required equipment is given below. This list is not all-inclusive and does not preclude the use of additional equipment.

1. A pneumatic drill capable of drilling 15-millimeter (19/32-inch) diameter holes through the slab.
2. A truck mounted pumping unit capable of injecting the polyurethane between the concrete and slab subbase. The pump shall be capable of controlling the rate of rise of the pavement.
3. A leveling unit to ensure that the slabs are raised to an even plane and to the required elevation as shown on the plans or as approved by the Engineer.

Field Survey and Grade Determination. The Contractor shall perform adequate surveys of the areas to be raised to determine that the existing profile grade line elevations are in agreement with the existing field survey. The Contractor shall use the existing data as a guideline and shall verify it with his own data to develop and present to the Engineer a proposed revised profile grade line. The revised profile grade line shall be approved prior to the start of any work on an area designated to be raised. The approved profile grade line shall then be used to guide the leveling of each area proposed to be raised.

Construction Methods. The Contractor shall drill or form the approved diameter holes, 15-millimeter (19/32-inch) minimum, at a spacing not to exceed 2 meters (6 feet) in any direction. A proposed hole layout pattern is shown in the Plans. Should the Contractor propose changes to the layout, the Contractor shall submit a revised hole layout pattern to the Engineer for review. These holes shall be of sufficient depth to penetrate through the concrete pavement, or deeper if directed by the Engineer. Penetration of the subgrade shall not exceed 75 millimeters (3 inches). For holes nearest the edge of the pavement slab, the slab joints, or a major crack, the holes may be relocated up to 75 millimeters (3 inches) from the precise locations of the hole. For all other hole locations, a relocation of up to 150 millimeters (6 inches) is acceptable. The drills shall be rotated to avoid cracking the pavement and to provide satisfactory holes of the proper diameter for effective operations. The equipment shall be in good condition and operated in such a manner that the holes are vertical and satisfactory for use. Unsatisfactory holes shall be filled and new holes shall be drilled.

The Contractor shall exercise sufficient care to ensure the slabs are not cracked or broken. Any slab that develops a crack that extends through the drill hole will considered to have been damaged during the process of the work and it shall be either repaired or replaced at no cost to the Tollway. Repair or replacement will be in accordance with techniques approved by the Engineer.

No more holes shall be drilled during a day's operations than can be filled during the same day, unless specific approval has been given by the Engineer. The polyurethane material shall then be injected under the slab. The amount of rise shall be controlled using the pumping unit, by measuring the rate of injection of the polyurethane material. The Contractor shall be responsible for any excessive or uneven pavement moving, and shall replace or repair any damaged areas as directed by the Engineer.

After the injection nozzle has been removed from the hole, any excessive polyurethane material shall be removed from the area and the hole sealed with the polyurethane material and non-expansive grout.

Work on this item shall not be performed when the pavement surface temperatures are below 1°C (34°F) or if the subgrade and or base course is frozen.

In the event the Engineer determines that continued material placement at any specific location is no longer economically feasible, he may direct the Contractor to cease work at that location. The Engineer will have the authority to modify the number of locations of work if excessive cost overruns are encountered.

The construction methods outlined above may be modified by the Engineer as field conditions dictate.

The pavement, including adjacent shoulders, shall be cleaned to the satisfaction of the Engineer prior to placement of traffic in the work area.

Method of Measurement. SLAB JACKING, SPECIAL will be measured by weight of polyurethane material placed beneath the slab as indicated by measuring devices at the pumping unit.

Basis of Payment. Payment for SLAB JACKING, SPECIAL, using high density polyurethane slurry, measured as specified, will be made at the Contract unit price per pound, which payment shall constitute full compensation for furnishing all labor, equipment, tools, and incidentals and doing all the work in raising existing Portland cement concrete pavement or precast slabs as shown on the Plans, as specified in these specifications and as directed by the Engineer.

2.4.3 Dowel Bar Retrofit (Illinois Tollway)

Description. This work shall consist of furnishing and installing epoxy coated round steel dowels into existing concrete pavement across transverse joints and/or cracks, in accordance with this Specification, at locations shown in the Plans and/or as directed by the Engineer. This work shall include sawing channels into the pavement, cleaning the channels, placing dowels into the channels, filling the channels and transverse joints with adhesive, cleanup and other related work.

<u>Materials.</u>

(a) Dowels. The dowel bars shall consist of a smooth, round, epoxy and bond breaker coated 18-inch long, 1.5-inch diameter steel dowels meeting the requirements of Article 1006.11(b).
(b) Bond Breaker. Acceptable bond-breaker compounds include white pigmented curing compound or other approved bond breaker materials.

(c) Expansion Caps. Use tight-fitting, commercial quality end caps made of a non-metallic, non-organic material that allows for ¼ inches of movement at each end of the dowel bar.

(d) Dowel Bar Support Chairs. Use chair devices for supporting the dowel bars that conform to the epoxy-coated steel requirements of ASTM A 884. Dowel bar chairs are used to firmly hold the dowels centered in the slots during backfill operations. The dowel bar chairs must hold the bar a minimum of ½ inch above the bottom of the slot while the backfill material is placed and consolidated.

(e) Foam Core Insert. A foam core insert shall be used to re-establish the joint or crack consisting of rigid Styrofoam material or closed cell foam, faced with poster board or plastic material.

(f) Caulking Filler. Caulking filler used for sealing the existing transverse or crack at the bottom and sides of the slot shall be concrete sealant that is compatible with the patch material being used.

(g) Non-Shrink Concrete Backfill Material. Use concrete backfill material tested as Rapid Set Concrete Patching materials per AASHTO and which conforms to ASTM C 928. Use material that: (1) provides a compressive strength of 4,000 psi in 24 hours (opening to traffic after 3,000 psi) per ASTM C 39; (2) exhibits expansion of less than 0.10 percent per ASTM C 531; and (3) has a calculated durability factor of 90.0 percent minimum at the end of 300 freeze-thaw cycles per ASTM C 666. Provide a concrete mix design to the Engineer 30 days prior to any placement operations.

<u>Submittals.</u> Submit samples to the Engineer for approval prior to the installation of the following items:

- Dowel bars
- Dowel bar chairs
- Dowel bar end caps
- Backfill material
- Aggregate for extension of backfill

Submit the material samples, except for the backfill and aggregate, at least 10 days prior to use. Submit backfill material and aggregate used for extension 30 days prior to use.

<u>Drawings.</u> The proposed location of the dowel bars is shown in the Plans. Before any fabrication is started, the Contractor shall prepare and submit shop drawings and/or catalogue cuts to the Engineer for approval, in accordance with the provisions of Article 105.04 of the Tollway

Supplemental Specifications. The shop drawings shall give full detailed dimensions and sizes of the channels to be sawed and the dowel bar retrofit.

Construction Methods. Install dowel bars in the existing Portland cement concrete pavement as shown on the Plans and in the Specifications.

(a) Saw Cutting. Make two saw cuts in the pavement to outline the longitudinal sides of each dowel bar slot. Saw to a depth and length that allows the center of the dowel to be placed at mid-depth in the pavement slab. Saw slots parallel to each other and to the centerline of the roadway with a maximum tolerance of ¼ inches per 12 inches of dowel bar length. Skewed joints or cracks may require slots longer than the length specified in the plans. Remove water and residue immediately after sawing.

(b) Concrete Removal. Remove the concrete remaining between the saw cuts. The materials shall be removed with a maximum of a 30-lb jackhammer or with hand tools. If the concrete removal operations cause damage to the pavement that is to remain, discontinue concrete removal operations and only resume after taking corrective measures. Repair or replace pavement damaged during concrete removal operations at no additional expense to the Tollway. The bottom of the slot must be flat and level. Dispose of any concrete removal debris.

(c) Slot Cleaning and Preparation. Sandblast all exposed surfaces in the dowel bar slot to remove saw slurry and debris such that clean aggregate is exposed. After sandblasting, clean the slot by blowing with moisture-free, oil-free compressed air having a minimum pressure of 150 psi to remove any dust, residue or debris left in the slot.

(d) Sealing Joints and Cracks in Slot. Seal the existing transverse contraction joint and/or all cracks at the bottom and the sides of the dowel bar slot with an approved caulking filler to prevent any of the backfill material from entering these areas. Prior to sealing, ensure that surfaces receiving the caulking filler are clean and free of moisture. Do not extend the caulking filler beyond 3/8 inches of each side of the existing joint or crack.

(e) Placing Dowel Assembly in Slot. Prevent contamination of the cleaned slot before or while placing dowel assemblies to limit the potential of bonding loss with the backfill material. Place the dowel bars to within 0.5 inches of the midpoint of the slab. Ensure that the bar is parallel to both the traffic lane centerline and the top of the roadway surface within a tolerance of ¼ inch per 12 inches of dowel bar length. Center dowels at the transverse joint or crack such that at least 7 inches of the dowel extends into each adjacent panel. Cease and adjust operations if the chairs do not hold dowel bars securely in place during placement of the backfill material.

    Place a foam core insert at the middle of the dowel bar and 2 inches below the surface of pavement. Place insert so it covers the existing transverse joint or crack and is capable of remaining in a vertical position, tight to all edges during backfill placement operations. Re-establish the joint or crack above the foam core insert within 4 hours of backfill placement by means of sawing when the backfill material has hardened sufficiently.

(f) Mixing and Placing Backfill Material. Mix backfill material in accordance with the manufacturer's instructions and the specifications. Refer to manufacturer's information on handling, mixing, and placing backfill material.

Fill each dowel bar slot with backfill material after placement of the caulking filler, the dowel bar, expansion caps, support chairs, and the foam core insert. Ensure that the foam core inserts remain upright and over the existing joint or crack during the backfill process. Vibrate the backfill material with a small hand held vibrator capable of thoroughly consolidating the backfill material into the slot around the dowel bars and support chairs.

Slightly overfill the slot and finish the surface of the filled slot level with the existing concrete. Cure backfill material in accordance with the manufacturer's recommendations. Apply curing compound within 60 seconds after placing the backfill material.

Method of Measurement. DOWEL BAR RETROFIT will be measured for payment by each dowel bar assembly installed.

Basis of Payment. Payment for DOWEL BAR RETROFIT, measured as specified, will be made at the Contract unit price per each, which payment shall constitute full compensation for furnishing all labor, material, tools, equipment, and incidentals involved in placing dowel bar retrofit, complete in place as shown on the Plans, as specified in these specifications and as directed by the Engineer.

2.4.4 Accelerated Portland Cement Concrete Pavement Patching (Illinois Tollway)

Description. This work shall consist of the removal of existing concrete pavement, restoration of the subbase material, the replacement with type of patch specified at designated locations, and the sealing of joints at locations designated by the Engineer, or as shown in the Plans, or described in the Special Provisions. The removal and replacement patching shall be performed within weekend lane closures or within lane closures as specified in the contract to allow for the specified minimum cure time.

This work will be classified as follows.

Accelerated Class A Patches:	Pavement Removal and Continuously Reinforced Portland Cement Concrete Replacement
Accelerated Class B Patches:	Pavement Removal and Portland Cement Concrete Replacement Using Dowels or Tie Bars
Accelerated Class C Patches:	Pavement Removal and Portland Cement Concrete Replacement

Materials. The Illinois Tollway Class AX portland cement concrete used for this special provision shall be in accordance with the Performance Related Special Provision for High Early Strength Cast-In-Place Concrete. All other materials for cast-in-place patching shall comply with Article 442.02 of the Standard Specifications except as modified herein.

Add the following to Article 442.02 of the Standard Specifications:

"(k) Chemical Adhesive Resin System (Note 5) 1027.01

(l) Calcium Chloride (Note 6)..1013.01

Note 5. A plastic or nylon adhesive retention disk that fits tightly over the dowel and effectively seals the gap around the hole is required to prevent flowable adhesive from running out of the hole. This disk is essential to successful anchoring of a dowel bar. This disk may be about 2 inches larger in diameter than the dowel being used and should be manufactured to fit snugly over the bar and slide up against the face of the slab when the bar is being inserted into the hole. The retaining disk is inserted over the dowel bar and pushed to flush against the PCC surface to retain the adhesive. The disk will keep most of the material in the dowel hole and provide an excellent bearing surface at the face of the slab.

Note 6. The calcium chloride accelerator, when permitted by the Illinois Tollway, shall be Type L (Liquid) with a minimum of 32.0 percent by weight of calcium chloride."

Equipment. Equipment for any cast-in-place patching shall be in accordance with Article 442.03 of the Standard Specifications.

Construction Requirements. The construction requirements for any cast-in-place patching shall be in accordance with Section 442 and 1020 of the Standard Specifications for Class A and Class B patching except as modified herein.

Revise the second paragraph of Article 442.05(c) of the Standard Specification to read:

"Non-reinforced pavement shall be scored by saw cutting. The scoring shall be at least 6 in. from the marked face of the patch. Marginal bars and tie bars shall be cut in a manner satisfactory to the Engineer. As an alternate, the Contractor may use an approved wheel saw to score the pavement full-depth on either standard reinforced or non-reinforced pavement. Should the wheel saw damage the pavement and/or reinforcement which are to remain in place, the Engineer will withdraw approval of this alternate."

Revise the third paragraph of Article 442.05(c) of the Standard Specification to read:

"The existing pavement shall be removed as shown on the plans. Ends of the patch shall be squared straight and perpendicular to the centerline of the pavement."

Add the following to Article 442.05 of the Standard Specifications:

(d) Patching Barricades

The openings resulting from concrete removal for pavement repair shall be protected with Type 1 barricades for the period beginning immediately after removal is completed and until the curing period for the new concrete has elapsed and all debris is cleared away.

A minimum of 2 barricades for each lane, in front of each opening, shall be provided. Where an opening is adjacent to a traffic lane, the barricade(s) shall be placed in the opening, (along the edge of the adjacent traffic lane) with a minimum of one barricade for every 12 feet of open excavation.

(e) Penalties

(1) Non-compliance with Specifications

The Contractor will be subject to a penalty of $500 per incident, to be deducted from the next pay estimate due the Contractor, for each occurrence when the Engineer determines that the Contractor or his Subcontractor is not in full compliance with Article 442.05(d).

(2) Failure to Respond

The Contractor shall be required to respond within ½ hour to any request from the Engineer for realigning, replacing or moving barricades or otherwise reestablishing compliance with Article 442.05(d). “Respond” is interpreted to mean on the job preparing to make repairs.

Failure by the Contractor to so respond shall be grounds for a penalty of $500 for each and every occurrence, to be deducted from the next pay estimate due the Contractor.

Revise the fourth sentence of the fourth paragraph of Article 442.06(a)(2) of the Standard Specifications to read:

“After the material has been positioned at the back of the hole, the dowel shall be fully inserted into the drill holes with retention disks against the face of the slab, using a back-and –forth twisting motion, leaving the proper length exposed as shown on the plans.”

Revise the first paragraph of Article 442.06(g) of the Standard Specifications to read:

“(g) Curing and Protection. Concrete patches shall be cured by the Wetted Burlap or Wetted Cotton Mat Method according to Article 1020.13 (a)(3) or Article 1020.13 (a)(5). The curing period shall be from the time of final setting of the mix until the patch is exposed to traffic no less than 16 hours after placement for concrete. In addition to Article 1020.13, when the air temperature is less than 55 °F, the Contractor shall cover the patch with minimum R12 insulation until opening strength is reached. Insulation is optional when the air temperature is 55 °F - 90 °F. Concrete shall not be placed when the air temperature is greater than 90 °F."

Replace the first paragraph of Article 442.09 of the Standard Specifications with the following:

Opening Patches to Traffic. No traffic will be permitted on a patch of Illinois Tollway Class AX portland cement concrete until after the minimum curing time of 16 hours, and after the concrete has obtained a minimum compressive strength of 2,500 psi.

Method of Measurement. When specified, pavement removal and replacement with accelerated Portland cement concrete patching using Illinois Tollway Class AX Portland cement concrete will be measured for payment and computed in square yards.

If additional pavement, subbase, or subgrade material is removed due to negligence on the part of the Contractor, the additional quantity of pavement removal and replacement or subgrade material will not be measured for payment. Shoulder removal and replacement resulting from edge forming will not be measured for payment.

When expansion joints are to be included in Class B patches, as shown on the plans or as directed by the Engineer, the expansion joint will be measured for payment in place in feet.

Reinforcement bars will be computed in square yards of surface area of the pavement patch in which the pavement reinforcement is installed, and no allowance will be made for laps, splices, or portions of bars not used.

Pavement fabric will be computed in square yards of the surface area of the pavement patch in which the pavement reinforcement fabric is installed.

All mandatory saw cuts for removal operations for Class A or Class B patches will be measured for payment in place in feet. Optional saw cuts with a concrete saw or wheel saw to aid the Contractor's removal operation will not be measured for payment. Optional wheel saw cuts allowed in lieu of mandatory saw cuts will be measured for payment as though the mandatory saw cuts were performed.

<u>Basis of Payment.</u> This work will be paid for at the contract unit price per square yard for ACCELERATED PORTLAND CEMENT CONCRETE PAVEMENT PATCHING, of the class, type and thickness specified.

When expansion joints are included in Class B patches, the expansion joint will be paid for at the contract unit price per foot for CLASS B PATCH – EXPANSION JOINT. The deformed bars will be paid for at the contract unit price per each for DEFORMED BARS – EXPANSION JOINT.

Where unsuitable material is encountered in the subgrade or subbase and its removal and replacement is required by the Engineer, such removal and replacement will be paid for according to Article 109.04 of the Illinois Tollway Supplemental Specifications.

When additional pavement removal due to unsound concrete or deteriorated steel is directed by the Engineer, the additional quantities will be paid for according to Article 109.04 of the Illinois Tollway Supplemental Specifications.

Dowel bars will be paid for at the contract unit price per each for DOWEL BARS, of the diameter specified.

Pavement tie bars for Class A and Class B patches will be paid for at the contract unit price per each for TIE BARS, of the diameter specified.

Reinforcement bars will be paid for at the contract unit price per square yard for PATCHING REINFORECMENT.

Mandatory saw cuts for Class A and Class B patches will be paid for at the contract unit price per foot for SAW CUTS.

When pavement reinforcement fabric is included in the contract it will be paid for at the contract unit price per square yard for PAVEMENT FABRIC. When pavement reinforcement fabric is required for patching, and a pay item is not included in the contract, the cost of the fabric will be paid for according to Article 109.04 of the Illinois Tollway Supplemental Specifications.

2.4.5 Surficial Partial Depth Pavement Spot Patching (Illinois Tollway)

Description. This work shall consist of partial depth patching at spot locations of isolated surficial pavement distress of an area or spalling that exceeds 4 inches in both width and length; does not exceed 18 inches in any one direction, and is greater than 2 inches in depth at any point within the area but not greater than half the pavement thickness in depth. The distress is typically seen adjacent to expansion or construction joints (spalls and corner breaks) and at locations of a removed or delaminated Raised Pavement Lane Marker (RPM). This work does not apply to extended length repairs of spalled joints, only to spot repairs within the specified limits for size.

Materials. The material used for surficial partial depth patching shall be a rapid setting (hard in one hour) Type I or Type III epoxy meeting the requirements of AASHTO M 237.

The Contractor shall submit the proposed material to the Engineer for review and acceptance 14 days prior to any placement operations.

Equipment. Mixing, pumping and placing equipment for the patching material shall be in accordance with the material manufacturer's instructions and specifications. Sandblast equipment shall effectively remove material from all exposed surfaces from the patch location and expose clean aggregate on those surfaces. The compressor for air blasting shall have a minimum capacity of 120 cu. ft. per minute. The compressed air shall be free from oil and other contaminants.

Construction Requirements. All spalls or openings adjacent to expansion joints or previous RPM locations that are within the specified tolerances for length, width, and depth shall be patched with the specified backfill material mixed and cured according to the manufacturer's recommendations.

Areas to be repaired will be determined and marked by the Engineer. A concrete saw shall be used to provide vertical edges approximately 3/4 in. deep in triangular or rectangular shape around the perimeter of the area to be patched when an overlay is not specified. The loose and unsound concrete shall be removed by chipping, with power driven hand tools. The maximum size pneumatic hammer shall be 30 lbs. Sandblast all exposed surfaces of the patch location to remove debris such that clean aggregate is exposed. After sandblasting, clean the spall by blowing with moisture-free, oil-free compressed air to remove any dust, residue or debris left in the opening. Any patching opening adjacent to or across a transverse or longitudinal pavement joint shall be filled with a block out material (waxed card board or fiber board, 3/16" to 1/4" thick) in such a manner to maintain the existing joint, and not fill the joint with patching material or have the patching material contact the adjacent pavement. Any patching opening adjacent to or across a crack shall be filled with a block out material (waxed card board or fiber board, 3/16" to 1/4" thick) in such a manner to maintain the existing crack, and not fill the crack with patching material. The block out material shall be placed on the entire depth of the joint or crack within the repair area.

The epoxy components of the repair material shall be mixed in strict compliance with the product manufacturer's recommendations. Saw cut runouts into any adjoining pavement shall be filled with the epoxy repair material. The final surface shall be flush with the surrounding pavement and no loose debris or patching material shall remain on the pavement after completing the patch.

Spot repairs shall only be allowed when the ambient air temperature is no less than 50 °F at the time of placement and curing. No spot repair locations shall be opened to traffic for at least 2 hours after the epoxy placement is completed.

Method of Measurement. This work will be measured for payment in place and the area computed in square feet. Any portion of this work constructed outside the dimensions shown on the Plans or as directed by the Engineer will not be measured for payment.

Basis of Payment. This work will be paid at the contract unit price per square foot for SURFICIAL PARTIAL DEPTH PAVEMENT SPOT PATCHING.

SECTION 3.0 REPAIR OF CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

3.1 Introduction

Continuously reinforced concrete (CRC) pavement is a type of portland cement concrete (PCC) pavement reinforced with transverse and continuous longitudinal steel. Because of the presence of the reinforcement, CRC pavement does not need to have regularly formed transverse joints. However, CRC pavement can have isolation joints and longitudinal joints, and it will have construction joints.

The purpose of this guide is to provide the Illinois Tollway with a method for determining the most appropriate pavement repair and preservation methods for CRC pavements based on visual conditions. As a part of pavement rehabilitation activities, repairs may be required to the existing CRC pavement to ensure a safe and smooth pavement surface for Tollway users. Typical repair types for CRC pavement included in this manual are:

- Full-depth reinforced concrete repairs
- Partial-depth concrete repairs

Typical preservation types for CRC pavement included in this manual are:

- Diamond grinding
- Slab stabilization
- Cross-stitching longitudinal joints and cracks

CRC repair types must be selected carefully to ensure that the final pavement surface is smooth, strong, and durable for the duration of the pavement's life. The selection of proper repair and preservation methods helps to provide a cost-effective and high-quality roadway. This manual provides the best practices guidelines for repair and preservation of CRC pavement.

3.2 Pavement Evaluation

Common CRC pavement distresses include punchouts, wide and spalled transverse cracks, wide longitudinal cracks, crack spalling, and joint deterioration (both construction and transition). Other distresses that may also occur in CRC pavements include faulting at construction/repair joints, pumping, blowups, and patch deterioration.

3.2.1 Surface Distress

Surface distress can occur due to the presence of too much reinforcement, low concrete cover, poor construction quality, and material issues during concrete placement. However, this is not distress due to structural deficiency but a surface defect that can eventually lead to additional durability and structural problems. Figure 11 shows a typical example of surface distress on CRC pavement.

Figure 11. Surface distress on CRC pavement.

3.2.2 Cracks

Longitudinal cracks are predominantly parallel to the pavement centerline. Poor construction techniques, subgrade settlement, and late saw cutting can lead to longitudinal cracks developing in CRC pavements. Longitudinal cracks commonly widen under repeated loading, allowing water to enter into the pavement structure.

Longitudinal cracks can also be caused by the combination of loss of support and traffic loading, which implies that longitudinal fatigue cracking occurred from the top of the pavement surface and propagated toward the bottom of the CRC pavement slab.

Some common types of longitudinal cracks and their causes include:

- Crack parallel to sawed centerline joint:
    - Caused by depth of longitudinal saw cut
    - Caused by late sawing or loading slab before sawing
- Crack in the interior (center 8 ft) of the lane:
    - Due to temperature stresses and/or base problems caused by inadequate compaction or subsequent moisture due to drainage issues

Either type of longitudinal crack can lead to crack spalling, eventual faulting, and infiltration of water causing further damage to the pavement structure. Transverse reinforcements are provided in CRC pavement so that, even if longitudinal cracks develop, the cracks are usually held tight and should not affect performance or require maintenance (Roesler, Hiller & Brand, 2016). However, if spalling occurs, filling the cracks with an appropriate material may help to reduce additional spalling.

Transverse cracks are predominantly perpendicular to the pavement centerline. This cracking is expected in a properly functioning CRC pavement. All transverse cracks that intersect an imaginary longitudinal line at mid-lane and propagate from the pavement edges (centerline joint or the edge joint) are counted as individual cracks, as illustrated in Figure 12. Cracks that do not cross the mid-lane are not counted.

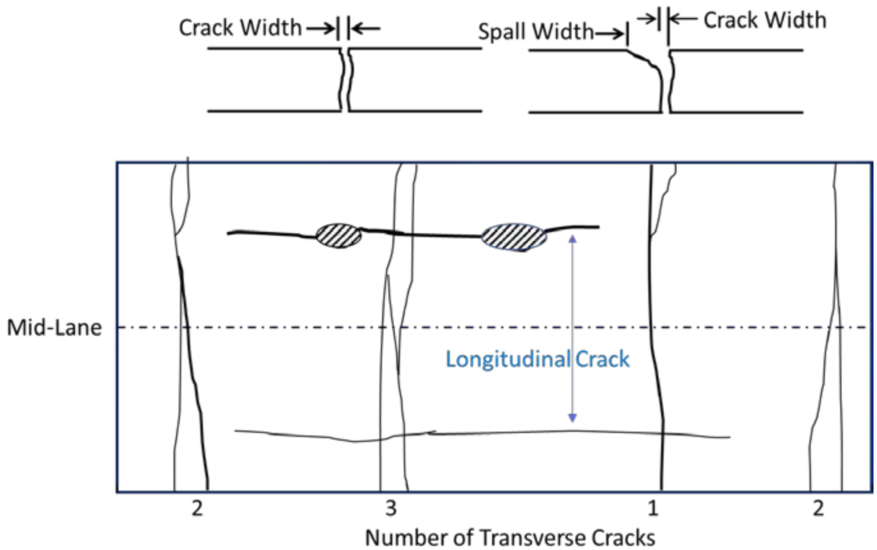


Figure 12. Schematics of transverse and longitudinal cracks, including spalling.

Transverse cracks are caused by drying shrinkage and temperature drops in the concrete slab over time and are expected to develop at 2 to 8-ft intervals over the first five years of pavement life. They are held tight by the longitudinal reinforcement in the slab and do not generally cause problems. Transverse cracks in CRC pavement should never be sealed or filled, as this will create excessive roughness.

3.2.2.1 Crack Severity

Crack severity is based on the width and spalling of the crack. According to the Federal Highway Administration (FHWA) Long-Term Pavement Performance Distress Identification Manual (LTPP-DIM), the severities of longitudinal cracks are defined as (Miller & Bellinger, 2014):

- **Low Severity:** Crack widths < 1/8 inch, no spalling, and no measurable faulting; or well-sealed and with a width that cannot be determined
- **Moderate Severity:** Crack widths ≥ 1/8 inch and < ½ inch, or with spalling < 3 inch, or faulting up to ½ inch
- **High Severity:** Crack widths ≥ ½ inch, or with spalling ≥ 3 inch, or faulting ≥ ½ inch

Figure 13 through Figure 15 show examples of low-, moderate-, and high-severity longitudinal cracks.

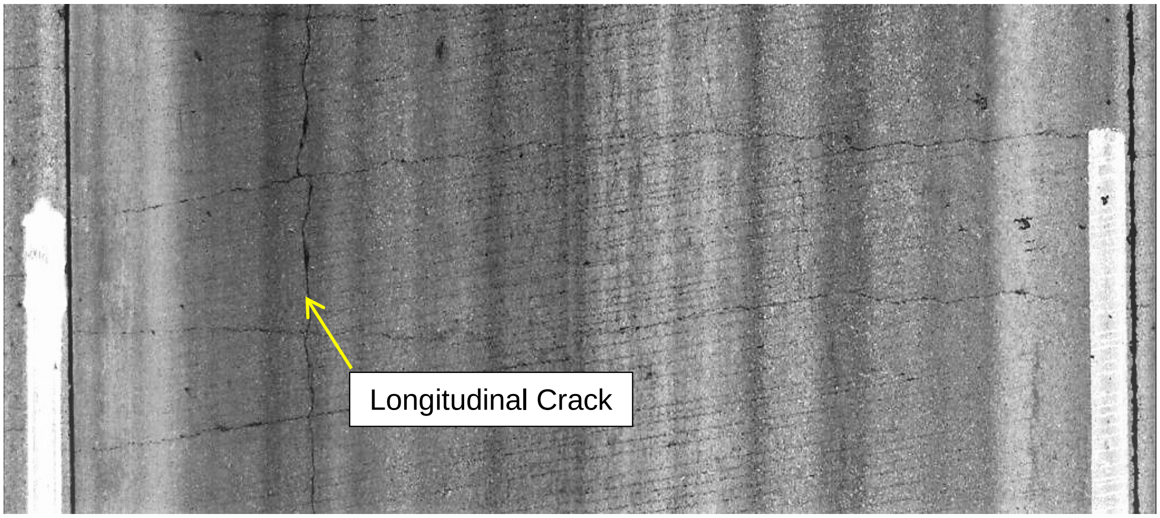


Figure 13. Low-severity longitudinal crack.

Figure 14. Moderate-severity longitudinal crack.

Figure 15. High-severity longitudinal crack.

According to the LTPP-DIM, the severities of transverse cracks are defined as:

- **Low Severity:** Cracks that are not spalled or less than 10% of the length of the crack has spalling
- **Moderate Severity:** Cracks with spalling along > 10% and ≤ 50% of the crack length
- **High Severity:** Cracks with spalling along > 50% of the crack length

Figure 16 through Figure 18 show examples of transverse cracks on CRC pavements.

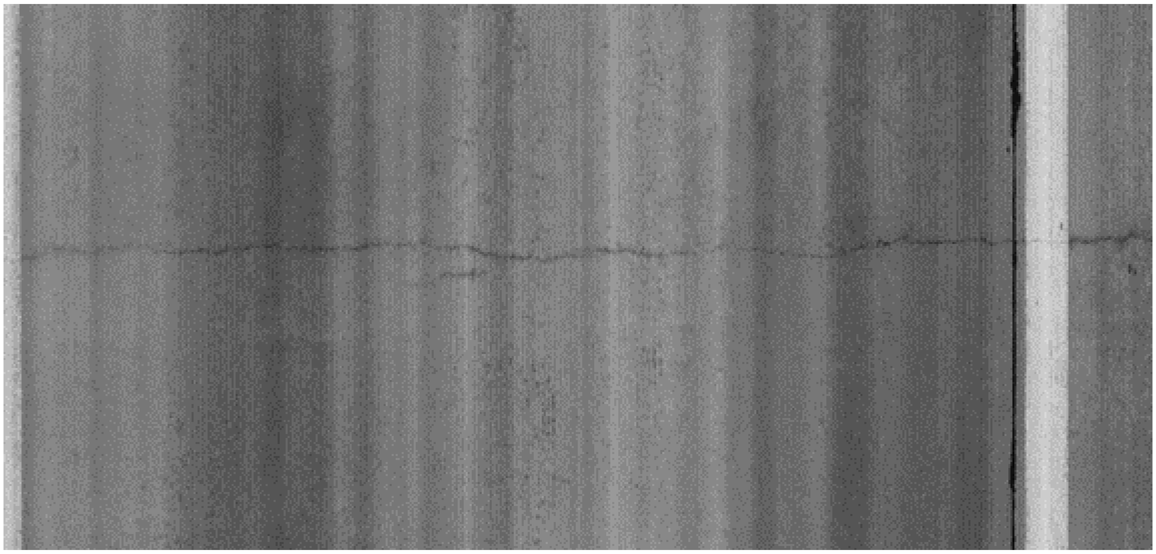


Figure 16. Low-severity transverse cracks on CRC pavements [IL 390 westbound, approx. MP 13.327].

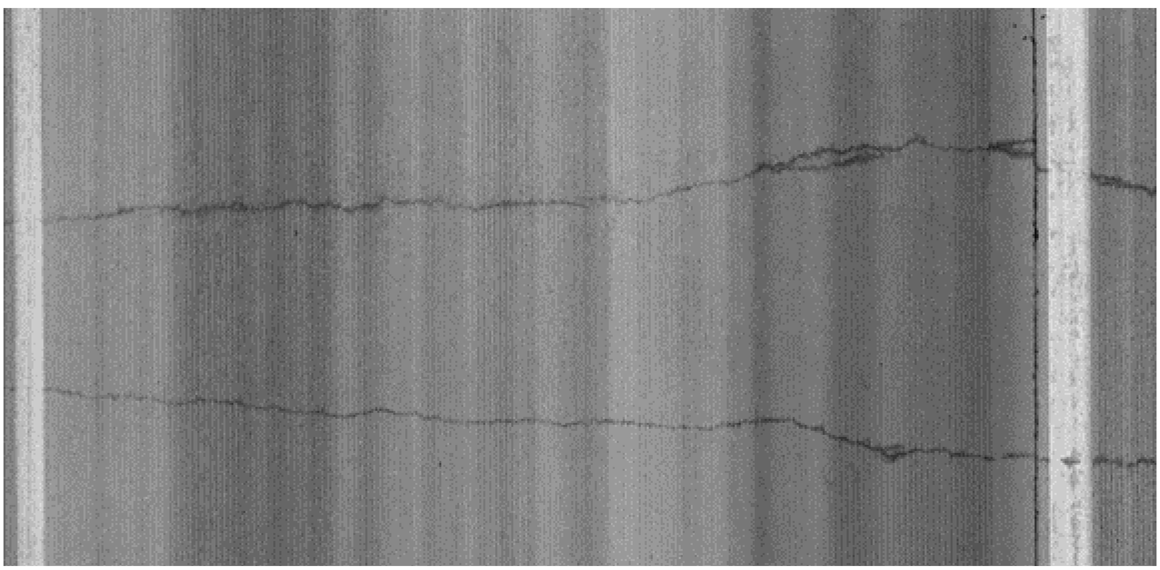


Figure 17. Moderate-severity transverse cracks on CRC pavement [IL 390 westbound, approx. MP 13.343].

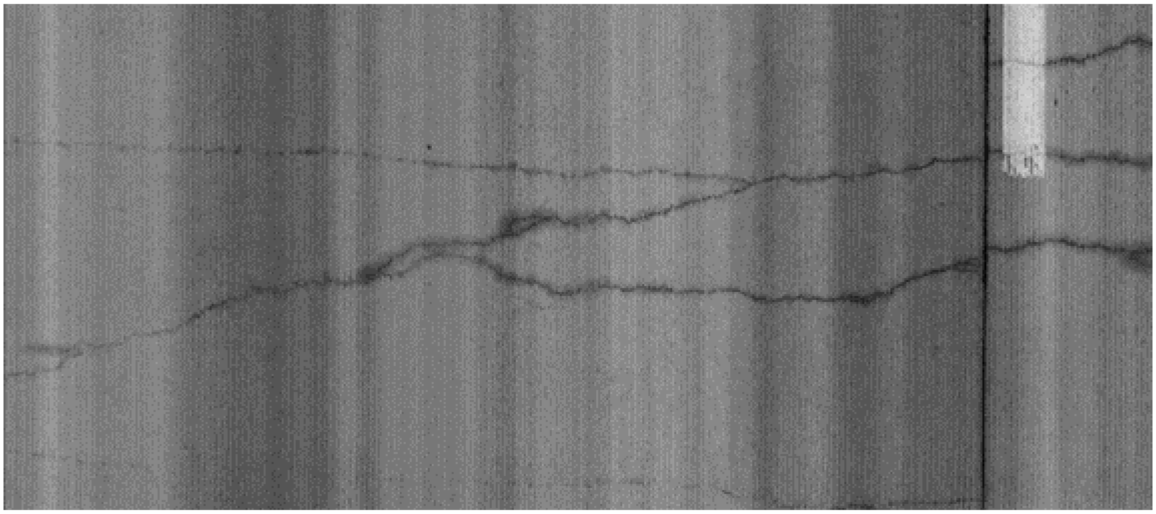


Figure 18. High-severity transverse crack on CRC pavement [IL 390 westbound, approx. MP 13.286].

If a transverse crack widens, it may be that the reinforcement has ruptured. Such a crack will open and close significantly, creating the potential for a blowup. These cracks must be repaired full-depth across all lanes/shoulders to avoid the possibility of a blowup occurring.

3.2.2.2 Spalled Cracks

Spalling in CRC pavement is the localized fracturing of concrete that happens along the cracks. Many factors contribute to crack spalling on CRC pavement, but most are due to the presence of pre-existing fractures that are propagated through cracks. For example, lack of moisture and associated drying shrinkage on the concrete pavement surface, type of coarse aggregate, and insufficient curing can result in poor quality concrete near the surface. This concrete is more prone to spalling, especially at transverse cracks in CRC pavement. Some other possible causes of spalled cracks in CRC pavement include:

- Aggregate shape and bond with paste
- Consolidation of concrete at steel due to excessive vibration effort
- Poor finishing and curing
- Infiltration of incompressibles

Figure 19 shows an example of a spalled transverse crack on CRC pavement.

If cracks are wide enough to allow the intrusion of incompressible materials, resulting expansion by the slab can cause stress concentrations in warmer weather. These stress concentrations can cause the concrete surface to spall in a reasonably short time, which contributes to spalling independent of traffic volume. Spalling can also be caused by the excessive deflection generated from traffic loading at pavement cracks.

Figure 19. Spalling along transverse crack (http://crcpavement.org).

3.2.2.3 Average Crack Spacing

The performance of CRC pavements is often assessed based on average crack spacing, which can also be used as a tool for calculating the percentage of spalled transverse cracks and evaluating whether the CRC pavement is acting as expected. Crack spacing can vary widely along any CRC pavement. However, locations of short spacing (<2 ft) are areas where structural punchouts may develop. Locations of extra-long crack spacing (>10 ft) are areas where cracks may become wider than normal and develop the potential for incompressible and moisture infiltration. If the mean crack spacing ranges between 3 and 8 ft, this is normal, and punchouts typically do not develop. Broad crack spacing (> 10.0 ft) can mean wider crack widths allowing for incompressibles and can lead to poor load transfer.

3.2.3 Punchouts

A punchout is a full-depth block of pavement, formed at the pavement edge when one short longitudinal crack forms between two existing transverse cracks, as shown in Figure 20. The existing transverse cracks are closely spaced, usually less than 4 ft apart. Punchouts are usually rectangular, but some may appear in other shapes. According to the Texas Department of Transportation (TxDOT), punchouts must be at least 12 inches long or wide to be rated as a punchout (TxDOT, 2019). For punchouts longer than 10 ft, rate one punchout for every 10 ft of length.

Figure 20. Punchout at CRC pavement (Jeon, Choi & Won, 2019).

Punchout formation is usually related to surface moisture infiltrating into the base through the closely spaced transverse cracks and the adjacent longitudinal joint, followed by erosion/pumping of the base and cantilevering of the small slab. In some cases, a transverse construction joint can serve as one boundary of a punchout, as seen in Figure 21. Heavy load applications will connect the transverse cracks with a short longitudinal crack. The punchout progresses with spalling of the cracks, possible rupturing of the reinforcing steel, and eventual settlement of the punchout below the original surface of the pavement.

Figure 21. Punchout at the construction joint.

Generally, poorly performing full-depth repairs exhibit large deflections at the transverse repair joints. The poor bond between tie bars and the surrounding concrete at repair joints contributes to large deflections and poor performance. A large deflection is typically observed at the beginning and ending joints of full-depth repair. Because of this kind of large deflection, along with the CRC discontinuity, punchouts can occur at transverse repair joints. Construction joint deterioration can occur for the following reasons:

- Inadequate vibration and consolidation
- Inadequate reinforcing details across a cold joint
- Lower adjacent slab temperature for a period of 5 days or more

Edge punchouts represent the major structural deterioration of CRC pavement and should only develop occasionally if the CRC pavement is designed and constructed properly. Edge punchouts are caused primarily by heavy repeated truck axles near the edge of the CRC pavement, causing fatigue damage to the top of the concrete slab. However, certain pavement conditions are also major risk factors, such as a base course that erodes or pumps (causing loss of support) or closely spaced transverse cracks (<2 ft) that deteriorate and spall and widen. When sufficient adjacent deteriorated CRC pavement is not removed during repairs, or where the loss of support has developed (or if another transverse crack is very close), an edge punchout can develop relatively soon after the repair is placed.

Figure 22 shows an edge punchout. The steps in formation of an edge punchout are as follows:

1. Deterioration of longitudinal joint seal between traffic lane and shoulder
2. Moisture infiltration leads to erosion, loss of support
3. Erosion, loss of support leads to high deflections at slab edge due to heavy traffic
4. Slab edge deflection leads to longitudinal cracking
5. Transverse cracks deteriorate and lose aggregate interlock
6. Concrete breaks into blocks
7. Steel bars yield or rupture

The development of more than a few punchouts along a typical CRC pavement is an indication of serious structural deficiency of the pavement. If fewer than five punchouts/mile exist in the heaviest truck lane, then a full-depth repair, partial-depth repair, or a preservation treatment is needed, depending on which approach is the most practical and cost-effective. However, if punchouts exceed 5 to 10 per mile in the heaviest truck lane, then the best solution may be a structural improvement such as a sufficiently thick overlay after repairs are completed.

Figure 22. Edge punchout on CRC pavement (Gulden, 2013).

3.3 Repair Technique Selection

Optimal repair techniques not only maintain or repair the existing structural and functional distresses but also prevent or postpone their reoccurrence so that the CRC pavement performs as originally designed. Repair techniques used on a project need to address the cause of the distresses. As a result, for each distress, one or more restoration alternatives might be needed. It is important to note that full-depth asphalt patches are not recommended as permanent repairs but only as temporary repairs. A plain concrete full-depth patch is not commonly used for CRC pavements.

The most cost-effective and reliable approach to selecting the best repair and preservation techniques can generally be based on the results from a visual survey, the level of truck traffic, and the pavement design:

- If the CRC slab has developed **serious durability problems (e.g., "D" cracking, alkali silica reactivity)**, then it will likely require a detailed review including cores and assessment of the extent and speed at which it will spread throughout the CRC pavement. The best approach may be to perform repairs as required and then eventually provide a thick structural overlay.
- If the CRC pavement slab has developed **serious structural problems (punchouts):**
    - If there are fewer than five punchouts/mile in the heaviest truck lane, then a full-depth repair, partial-depth repair, and any preservation treatments that may be needed should be the most cost-effective.

- If punchouts exceed 5 to 10 per mile in the heaviest truck lane, then the best solution may be a structural improvement such as a sufficiently thick overlay after needed repairs are completed, or reconstruction.

Most CRC pavements constructed by the Illinois Tollway have been well designed and include proper amounts of longitudinal reinforcement, very durable hot-mix asphalt (HMA) base course, and lower unbound layers that should carry heavy truck traffic over 40 years into the future. However, there may be construction defects that deteriorate over time that need to be resolved with full-depth or partial-depth repairs. And while full-depth and partial-depth repairs are critical, preservation techniques including cross-stitching longitudinal cracks and joints, slab stabilization, and diamond grinding can be valuable in extending the life of the CRC pavement. Extending the service life of high-traffic CRC pavement projects is very cost-effective and highly sustainable.

Table 2 shows the expected improvement in service life for a variety of CRC pavement repairs.

Table 2. Repair types and expected service life.

Repair Type	Expected Service Life (years)
Surficial Partial-Depth Patch	5 - 10
Diamond Grinding (small segments)	5 - 8
Diamond Grinding (large area)	7 - 10
Full-Depth Patch (Standard/Precast)	10 - 20
Cross-Stitching	10 - 20
Slab Stabilization/Undersealing	10 - 20

3.3.1 Surface Repair/Partial Depth Repair

Partial-depth repairs are rarely used for CRC pavement because the reinforcing steel is so close to the surface and obviously cannot be cut or damaged. For example, partial-depth repair should not be used when spalling of the surface has occurred over a larger area due to high reinforcement. However, partial-depth repairs may be appropriate on small, isolated areas of surface defects.

The first step to determine whether partial-depth repair is the optimum repair strategy is to evaluate the nature of the distress. Figure 23 shows an example of the type of area where partial-depth repair would be a viable solution.

For all partial-depth repairs, the boundary of the repair area has to be established. Transversely, the boundary should contain all longitudinal cracks or fractured concrete. Longitudinally, the limit should extend to about 2 to 3 inches beyond the transverse cracks that define the distress area. Repair areas should not be closer than 6 inches to any other transverse crack or joint. The minimum size of the repair area should be 1 ft in both longitudinal and transverse directions. Repair boundaries are saw cut to a maximum of one-third of the slab depth if the slab thickness is less than 14 inches. Saw cut depth should not be so deep as to cut the longitudinal steel.

Figure 23. Example of distress that requires partial-depth repair.

The success of partial-depth repair depends on:

- Proper selection of candidate projects
- Proper selection of patching material
- Selection of optimum repair boundaries
- Achieving a good bond between patching materials and the existing pavement
- Clean and dry repair area
- Sandblasting sidewalls
- Proper application of bonding agent
- Timely placement of repair material
- Proper placement and curing

3.3.2 Conventional Cast-in-Place Full-Depth Repair

Full-depth repairs are used to repair severely deteriorated punchouts, joints, or cracks in CRC pavement when other maintenance procedures can no longer correct them. Full-depth repairs restore locally damaged areas to near-original condition, with similar smoothness and structural integrity. Full-depth CRC patches are generally expected to provide the best performance for CRC pavements. Guidelines for full-depth repairs are as follows:

- Full-depth transverse saw cuts should maintain a minimum distance of 18 inches from the end of the repair to the nearest transverse crack in the pavement or other significant concrete deterioration
- Minimum repair dimension should be 4.5 ft from outer full-depth saw cuts
- Transverse cuts should be perpendicular to the centerline and should not cross skewed cracks; if necessary, cut along rather than across skewed cracks
- The transverse rebar shall be tied to the bottom of the longitudinal rebar when the minimum clearance of 2 inches from the top of the slab cannot be obtained with the transverse bar on the top

- The reinforcing steel in the splicing area shall not be bent to aid in the removal of the concrete and should follow the IDOT Class A patch standard

Figure 24 shows a completed full-depth repair in CRC pavement.

Figure 24. Example of full-depth patching of CRC pavement.

3.3.3 Rapid Full-Depth Repair with Precast Concrete

The essential features of the full-depth repair with precast concrete panels can be summarized as:

- Maintains the continuity of the longitudinal steel reinforcement within any CRC pavement repair area by locating the longitudinal bars within the existing CRC pavement and overlapped with longitudinal steel bars in the precast concrete panel (PCP)
- Maintains continuity of the longitudinal steel through the repair areas, matching the steel content of 0.8 percent in the existing pavement

Figure 25 shows an area of precast CRC patching on the Illinois Tollway.

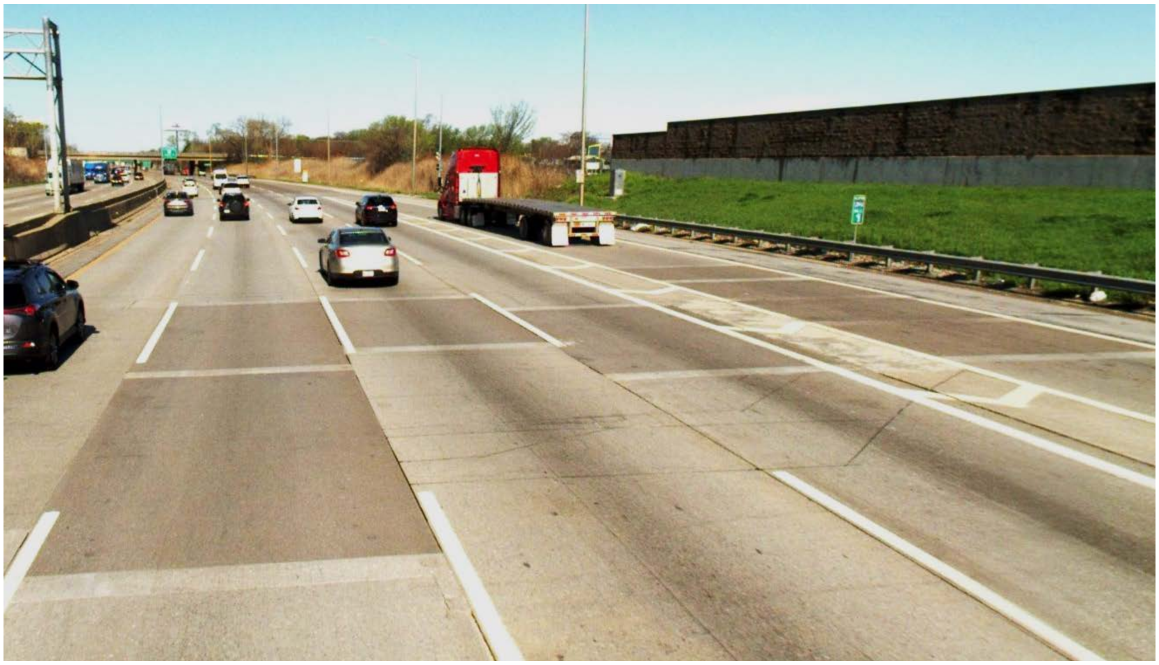


Figure 25. Example of rapid full-depth repair with precast concrete.

3.3.4 Cross-Stitching

Cross-stitching is a well-established technique applied to an existing concrete pavement that has longitudinal joints that need to be kept tight over time. Deformed reinforcement bars are anchored into holes drilled at an angle with the horizontal and at prescribed spacing along the joint into the concrete slab.

In CRC pavement, cross-stitching is utilized where lanes are separating at the longitudinal construction joints. transverse and longitudinal reinforcements are provided, and cracks are held tight and typically do not cause pavement distress. The key aspects that are critical to the successful installation of cross-stitching are:

- Knowing the thickness of the slab that is going to be stitched
- Controlling the angle of the drill
- Making sure the drill cannot penetrate the bottom of the slab
- Checking the hole location (distance from the joint or crack) and spacing
- Verifying the size of the tie bar
- Monitoring the anchoring process, including cleaning of the hole and insertion of epoxy and bar in the specified rotational way
- Making sure that the drilling and anchoring procedures do not spall the surface of the concrete

Deformed tie bars, with a diameter of 0.75 inches, spaced at 20 to 30 inches, are grouted into holes drilled at 30 to 45 degrees to the pavement surface, as depicted in Figure 26 and Figure 27. The tight joint maintains excellent load transfer and slows the rate of deterioration.

Figure 26. Example of cross-stitching to control longitudinal crack in jointed plain concrete pavement (IGGA, 2010).

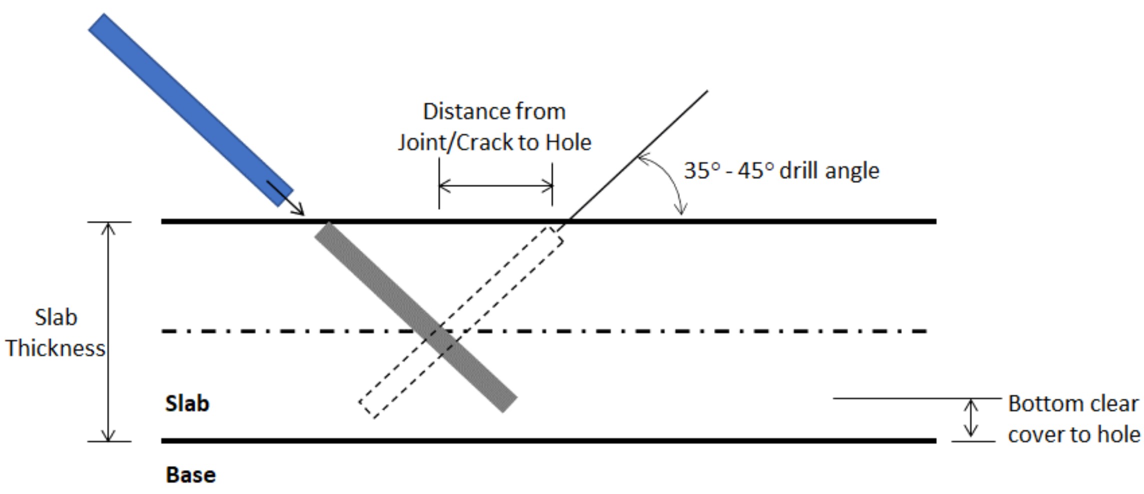


Figure 27. Cross-section view of cross-stitching (redrawn from IGGA, 2010).

3.3.5 Diamond Grinding

Diamond grinding is used predominantly on jointed concrete pavements, but it has also been used successfully on CRC pavement. Diamond grinding is intended to restore smoothness and increase friction resistance. Diamond grinding removes a thin layer of the concrete surface, approximately 0.25 inches, to reduce surface irregularities and wheelpath rutting caused by studded tires (see Figure 28). This also improves pavement surface texture, reduces road noise, smooths out roughness caused by repairs, and can improve drainage by restoring transverse cross slope, if needed. Diamond grinding can reduce the International Roughness Index (IRI) by 20 to 80 percent (50 percent is typical) when it is done in combination with other repairs.

Figure 28. Diamond ground surface (TxDOT, 2019).

The following factors should be considered before diamond grinding CRC pavements:

- It is more effective when used in combination with repair and restoration techniques because it does not increase the structural strength of the pavement
- It should not be used on pavements with material-related distress
- It should not remove material to the point that concrete cover over the reinforcement becomes inadequate
- Surface friction issues can arise if the candidate pavement was constructed with coarse aggregates, which are susceptible to polishing under traffic
- Recommended blade spacing to achieve optimum texturing is strongly related to concrete coarse aggregate hardness; softer aggregate requires a wider blade spacing

3.3.6 Slab Stabilization/Undersealing

Slab stabilization/undersealing is a pavement repair method that fills voids underneath the concrete slab to diminish pumping, reduce slab deflections and distresses (e.g., punchouts), and improve the uniformity of foundation support. Utilizing an effective material may also reduce future erosion, providing additional significant long-term benefit. Polyurethane is used extensively and has shown a significant increase in joint load transfer efficiency (LTE) after slab stabilization.

The ability to reliably identify the location of voids under the slab is critical. For slab stabilization, the first step in the process is locating the areas of voids beneath the slab caused by the base material deterioration. Deflection testing, generally performed using a falling weight deflectometer (FWD), is the most commonly used and most effective method for identifying loss of support. Ground-penetrating radar (GPR) equipment and data interpretation techniques have enabled the detection of air-filled voids as thin as 0.25 inch.

Key issues related to slab stabilization include:

- Successful slab stabilization is limited to slab locations where deflection testing indicates loss of support. If slab stabilization is done where there are no voids, pumping material beneath the slab will cause stress points and increase pavement deterioration.
- Using the right quantity of material to stabilize the slabs is also an essential factor. Excess amounts of materials will result in the raising of slabs, sometimes resulting in cracking. However, too little material will not fill all the voids, and loss of support will still exist.
- Effective specifications and procedures will result in proof of slab stabilization by material seeping from adjacent joints and cracks, vertical slab movement, or other visual indicators.
- High-quality materials should always be used to fill voids beneath the slabs. High-density, two-component, water-resistant polyurethane material is the primary slab stabilization material used today.

3.4 Literature Review

3.4.1 CRC Pavement Condition Evaluation

Evaluation of the existing CRC pavement condition is critical to determine the appropriate repair method. Transverse cracks are expected in a properly functioning CRC pavement and technically are considered as distresses only if spalling develops. Transverse crack spacing on a CRC pavement can be an indicator of future performance. The Virginia DOT requires average transverse crack spacing to be reported as a part of CRC pavement condition evaluation (Virginia Department of Transportation, 2012).

Punchouts are the most significant distress for CRC pavement. A significant cause of punchouts is not only traffic loading but also a weakened support condition. TxDOT research indicates that punchouts may occur without forming two transverse cracks in situations with reduced base support (Jeon, Choi & Won, 2019).

Since the traffic loading cannot be transferred from a CRC lane to an asphalt shoulder, the pavement edge deflection due to traffic loading is generally larger than in situations where there is a tied concrete shoulder. If the joint between the outside CRC lane and asphalt concrete shoulder is susceptible to pumping, a deficiency in the slab support is likely. This can lead to edge punchouts.

A recent TxDOT research report noted that about 21% of the total punchouts surveyed in CRC pavement were observed at the transverse construction joint (Jeon, Choi & Won, 2019). Figure 11 shows an example of this phenomenon. One cause for distress at or near the transverse construction joint is the quality of the in-place concrete. The concrete placed in the morning is the first batch of concrete of the day, and its quality might differ from that of the later batches. As paving slows at the end of the day and the paver gets stopped, a construction joint is created. For the construction joint, the concrete placement, including consolidation, is done primarily by hand. The concrete mix can also be extra dry sometimes. Areas at construction joints also have a substantial amount of longitudinal steel (regular steel plus lap steel) that might hinder proper compaction of concrete.

The same TxDOT study also found about 19% of the total punchouts surveyed in CRC pavement were observed at a repair joint. Figure 29 shows an example of this phenomenon. According to the research findings, the primary cause of the distress at the repair joint was poor full-depth repair work.

To evaluate the feasibility of different repair techniques, it is imperative to consider both the structural and functional conditions of the CRC pavement. The purpose of the repair is to restore, as closely as possible, the original capacity of the pavement. Table 3 summarizes the repair techniques for CRC pavement distresses, as reported in a recent FHWA study.

Figure 29. Punchout at repair joints (Ryu, Choi, Choi, & Won, 2013).

Table 3. Repair techniques for CRC pavement distresses (Roesler, Hiller, & Brand, 2016).

Distress	Repair Technique
Structural Distress	
Pumping	Slab stabilization, Full-depth repair

Longitudinal cracking	Full-depth repair or cross-stitching
Joint or crack spalling	Full-depth repair (spall depth >D/3), Partial-repair depth (spall depth <D/3), Shoulder repair
Blowup	Full-depth repair
Punchouts	Full-depth repair, Shoulder repair/retrofit
Transition joint deterioration	Reconstruct joint
Patch deterioration	Full-depth repair
Functional Distress	
Roughness	Diamond grinding
Scaling	Partial-depth repair (spall depth <D/3), Diamond grinding
Surface polishing/low friction	Diamond grinding

D = Pavement thickness

3.4.2 Partial-Depth Repair

Some transportation agencies, such as Wisconsin DOT, do not apply partial-depth repairs for CRC pavement (Wisconsin Department of Transportation, 2003). Others, such as TxDOT, perform partial-depth repair for the distress that is confined to the top half of the slab, above the longitudinal steel (Yeon, Choi, Ha, & Won, 2012).

Chen, Lin & Sun (2010) reported that three types of distresses make partial-depth repair suitable for a CRC pavement: spalls, wide cracks, and punchouts due to mid-depth horizontal cracks. The performance of partial-depth repair varies substantially. Polyurethane-based materials were used to repair spalling, and these materials provided satisfactory performance for more than 9 years.

3.4.3 Conventional Cast-in-Place Full-Depth Repair

A TxDOT study revealed that the primary cause for the poor performance of full-depth repairs is the failure to restore structural continuity at transverse repair joints (Ryu et al., 2013). A common characteristic of poorly performing full-depth repairs is large deflections at transverse repair joints. The poor bond between tie bars and the surrounding concrete at repair joints appears to contribute to these large deflections and poor performance.

The same TxDOT study reviewed CRC pavement full-depth repair practices of a few states and evaluated similarities and differences with TxDOT practices. Until the mid-1990s, the method that TxDOT typically used was to make full-depth saw cuts about 18 to 24 inches from the transverse repair joints, as shown in Figure 30. Partial-depth saw cuts, approximately 2 inches deep, are made on each end of the CRC pavement repair for splicing of the longitudinal steel reinforcement. Jackhammers and hand chipping tools are used to chip away the existing PCC to expose the steel reinforcement to which the new steel is tied. After the base is repaired (if needed) and longitudinal and transverse steel is placed, the repair concrete is placed.

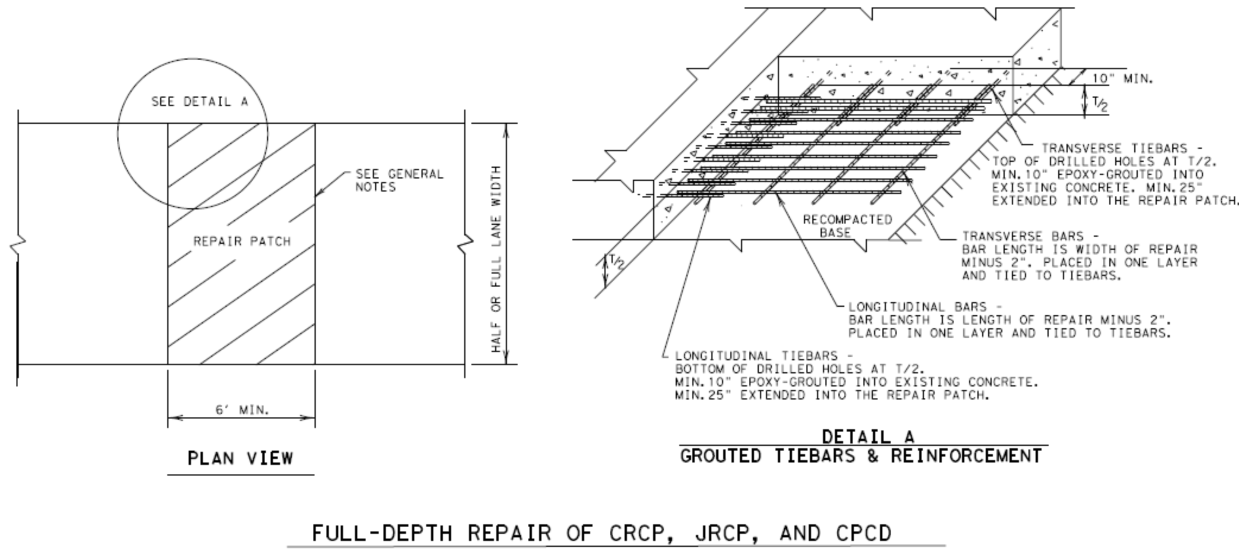


Figure 30. TxDOT full-depth CRC repair detail (TxDOT, 2014).

Figure 31 shows a similar Illinois DOT detail.

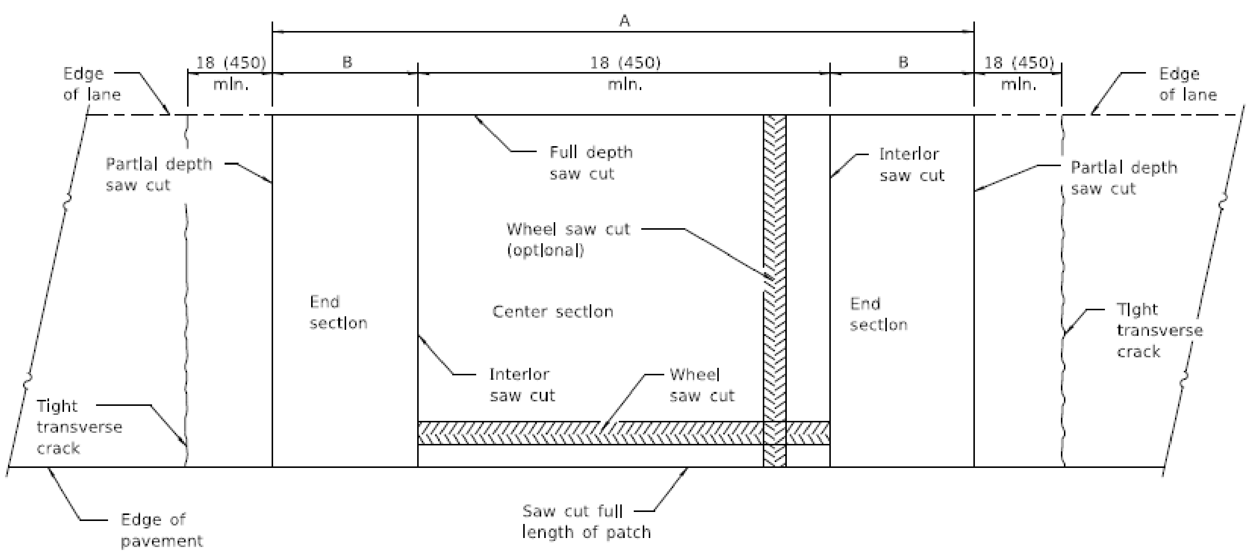


Figure 31. Saw cut for the full-depth patch in CRC pavement (Illinois DOT, 2008).

3.4.4 Rapid Full-Depth Repair with Precast Concrete

The Illinois Tollway recently implemented a method for rapid, overnight, full-depth repairs of CRC pavements using precast concrete panels (Gillen, Gancarz & Tayabji, 2018). Two types of splice zones were used to maintain steel continuity:

- The first splice zone, located where a precast panel is placed next to an existing CRC pavement, maintains continuity between the original CRC pavement and the CRC precast panel

- The second splice zone detail was developed for connections between precast panels where multiple precast panels were placed in sequence within a repair area

During construction, a full-depth temporary precast panel is used to cover the splice zone gap during the panel placement. When the temporary precast panel is removed, the gap is filled with a fiber-reinforced ultra-high-performance concrete (UHPC) or an approved high early-strength concrete (HESC).

Figure 32 illustrates the relative positioning of the precast panels and splice zones in the full-depth repair area.

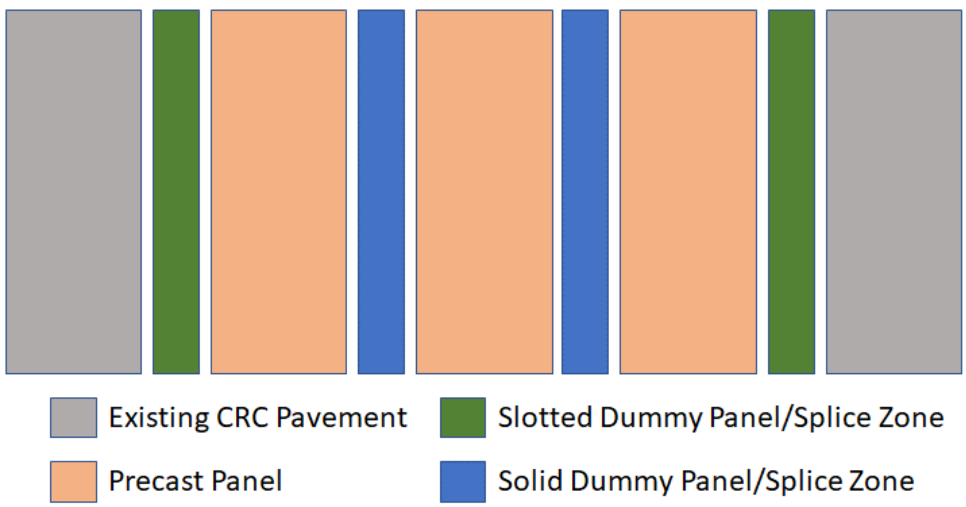


Figure 32. Plan view of a repair area with multiple PCP panels (adapted from Gillen, Gancarz & Tayabji, 2018).

3.4.5 Cross-Stitching

Darter (2017) reported that a few states, including Kansas, Missouri, Minnesota, and Utah, perform cross-stitching on concrete pavements of all ages to prevent a longitudinal crack or joint from opening up and creating a roughness, maintenance, and/or safety problem. It was reported that more than 20 years of service could be expected from a cross-stitching repair if performed correctly. A schematics of cross-stitching is shown in Figure 33.

Cross-stitching is applicable for several situations where strengthening joints or cracks is required, including the following (ACPA, 2001):

- Strengthening longitudinal cracks in slabs to prevent slab migration and to maintain aggregate interlock
- Mitigating the issue of tie bars being omitted from longitudinal contraction joints (due to construction error)
- Tying pavement lanes or shoulders that are separating and causing a maintenance problem
- Tying centerline longitudinal joints that are starting to fault

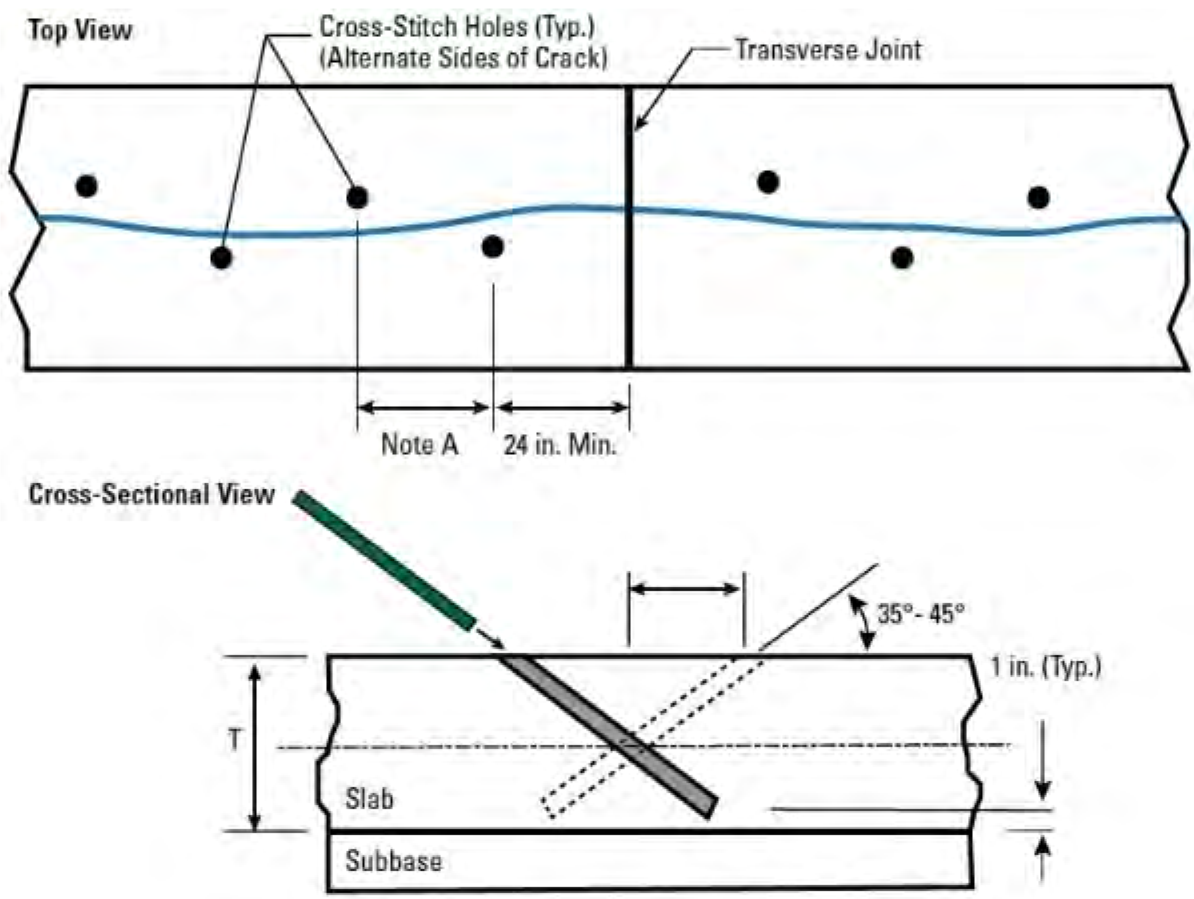


Figure 33. Schematics of cross-stitching on CRC pavement (adapted from IGGA, 2010).

3.4.6 Diamond Grinding

Darter (1992) reported that several CRC pavement projects in Belgium were diamond ground to remove a harsh cross-tining that created significant tire/pavement noise and vibration levels. The noise and vehicle vibration levels were significantly reduced, and a comfortable ride was provided on those projects.

Buddhavarapu, de Fortier Smit, Banerjee, Trevino, & Prozzi (2013) evaluated the benefits of diamond grinding on CRC pavement. They found that grinding increased skid resistance by about 60%, and a considerable positive correlation was evident between the surface friction and surface macrotexture. Most importantly, IRI decreased from 124 inches/mile to 44 inches/mile. Diamond grinding also reduced the average overall noise level.

3.4.7 Slab Stabilization/Undersealing

Slab stabilization is achieved by injecting a highly flowable material underneath the slab. The process restores the base support under transverse and longitudinal joints that have been eroded. Repeated heavy axle load, excess free water, and erodible materials in the base, subbase, and subgrade can cause erosion. Darter (2017) identified three critical issues for successful slab stabilization, including:

- Limiting the usage of materials to locations where deflection testing indicates loss of support. However, slab corners may not develop a loss of support significant enough to be identified.
- Implementing effective specification and procedures should ensure that holes are drilled completely through the slab.
- Using appropriate materials. The primary types of slab stabilization materials used over the years include:
    - Cementitious grouts, used extensively in the past by agencies such as Georgia DOT. However, usage of cementitious grout has declined in recent years due to its erosion potential.
    - Asphalt cement with low penetration and a high softening point.
    - High-density, two-component, water-resistant polyurethane material, which is the primary slab stabilization material used today. Polyurethane can flow into very fine voids and expands up to six times its liquid volume, forcing its way into any sized void.

3.5 References

American Concrete Pavement Association (ACPA). (2001). Stitching Concrete Pavement Cracks and Joints. Special Report SR903P. American Concrete Pavement Association, Skokie, IL.

Buddhavarapu, P., de Fortier Smit, A., Banerjee, A., Trevino, M., & Prozzi, J. A. (2013). Evaluation of the Benefits of Diamond Grinding of a Continuously Reinforced Concrete Pavement. Transportation Research Record, 2369(1), 59–67. https://doi.org/10.3141/2369-07

Chen, D. H., Lin, H. H., & Sun, R. (2010). Field Performance Evaluations of Partial-depth Repairs. Construction and Building Materials, 25(3), 1369-1378.

Darter, M. I. (1992). Report on the 1992 U.S. Tour of European Concrete Highways, FHWA-SA-93-012, Federal Highway Administration, Washington, D.C.

Darter, M. I. (2017). Concrete Repair Best Practices: A Series of Case Studies. Final Report CMR17-013, Prepared for Missouri Department of Transportation.

Gillen, S., Gancarz, D., & Tayabji, S. (2018). Precast Concrete Panels for Rapid Full-Depth Repair of CRC Pavement to Maintain Continuity of Longitudinal Reinforcement. Tech Brief, FHWA-HIF-18-050. Federal Highway Administration, Washington, DC.

Gulden, W. (2013). Continuously Reinforced Concrete Pavement: Extending Service Life of Existing Pavements, Report FHWA-HIF-13-024, FHWA, Washington, D.C.

Illinois Department of Transportation. (2008). Highway-Standards, 2008, https://idot.illinois.gov/Assets/uploads/files/Doing-Business/Standards/Highway-Standards/PDF/223-442001-04_ClassApatches.pdf. Accessed on April 20, 2020.

International Grooving and Grinding Association (IGGA). (2010). Stitching Concrete Pavement. International Grooving and Grinding Association, West Coxsackie, NY.

Jeon, S., Choi, P., & Won, M. (2019). Punchout Evaluations and Classification of Continuously Reinforced Concrete Pavement to Improve Pavement Design, Road Materials and Pavement Design, DOI: 10.1080/14680629.2019.1701538

Miller, J. and Bellinger, W. (2014). Distress Identification Manual for the Long-term Pavement Performance Program. Fourth Revised ed. FHWA Report No. FHWA-RD-03-031. FHWA, McLean, VA.

Roesler, J., Hiller, J., & Brand, A. (2016). Continuously Reinforced Concrete Pavement Manual: Guidelines for Design, Construction, Maintenance, and Rehabilitation.

Ryu, S., Choi, P., Choi, S., & Won, C. (2013). Improvements of Full-Depth Repair Practices for Distresses in Continuously Reinforced Concrete Pavement. Transportation Research Record, 2368(1), 102–113. https://doi.org/10.3141/2368-10.

Texas Department of Transportation (2014). Repair of Concrete Pavement. REPCP-14. https://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/roadway/repcp14.pdf. Accessed August 31, 2020.

Texas Department of Transportation (2019). Pavement Manual. http://onlinemanuals.txdot.gov/txdotmanuals/pdm/pdm.pdf. Accessed April 20, 2020.

Virginia Department of Transportation (2012). A Guide to Evaluating Pavement Distress Through The Use of Digital Images, Version 2.6. http://www.virginiadot.org/business/resources/local_assistance/A_Guide_to_Evaluating_Pavement_Distress_Through_the_Use_of_Digital_Images_v2.6_1.pdf. Accessed June 17, 2020.

Wisconsin Department of Transportation (2003). Concrete Pavement Partial Depth Repair. SDD 13c8. https://wisconsindot.gov/rdwy/sdd/sd-13c08.pdf. Accessed on May 20, 2020.

Yeon, J., Choi, S., Ha, S., & Won, M. (2012). Guidelines for Partial Depth Repair in Continuously Reinforced Concrete Pavement. Project Number 0-5549, Texas Department of Transportation and the Federal Highway Administration, Lubbock, TX.

3.6 Appendix A – Accelerated Portland Cement Concrete Pavement Patching (Nov. 1, 2016)

3.7 Appendix B – Surficial Partial-Depth Pavement Spot Patching (Aug. 1, 2017)

3.8 Appendix C – Diamond Grinding for Continuously Reinforced Portland Cement Concrete Pavement and Shoulder (May 12, 2020)

SECTION 4.0 MATERIAL TRANSFER DEVICE USAGE

4.1 Introduction

4.1.1 Objective

The objective of these Guidelines is to provide a reference regarding the allowable usage scenarios for Material Transfer Devices (MTDs) when considering pavement strength development and device offset from a free edge of a Portland cement concrete (PCC) pavement.

4.1.2 Background

MTDs are required when placing full-depth Warm Mix Asphalt (WMA) and overlays of existing concrete. The MTDs are needed to ensure that the asphalt binder and surface layers do not experience segregation as they are placed along the mainline composite pavement and adjacent full-depth asphalt shoulders. The MTD also provides a steady flow of material to the paver and may be used to facilitate placement of other mixtures. By keeping the speed of the paver and the head of material constant, the MTD contributes to the pavement smoothness.

The Tollway Special Provision for Material Transfer Devices allows an MTD to be used on a concrete pavement if the tire pressure is below 80 psi, the axle load is below 64,000 lbs, the concrete has reached a compressive strength of 3,500 psi, and the MTD is kept a minimum of 4 feet away from a free edge. A free edge is defined as a longitudinal concrete pavement joint not tied to a concrete pavement lane, shoulder, moment slab, or other structure, as Tollway standards do not allow tying mainline concrete pavement to full-depth asphalt shoulders or to moment slabs.

These guidelines have been developed to provide a reference should other types of MTDs be proposed for conditions beyond those referenced in the Tollway SP for Material Transfer Devices. Requests for allowance of other MTDs should be submitted via the Tollway's WBPM system (e-Builder) with as many details as possible to allow for the most accurate analysis possible. In anticipation of those types of requests and/or situations, the Tollway evaluated several different MTDs as described below. Each MTD was modeled in a finite element program (I-SLAB) across a range of concrete strength values to determine the maximum tensile stress expected at the bottom of the concrete slabs. If the induced tensile stress exceeds the modulus of rupture for the concrete, the Jointed Plain Concrete Pavement (JPCP) slabs are at risk for developing pre-mature mid-slab cracks, which would reduce the effective life of the pavement.

4.1.3 Relevant Pavement Alignments

ARA modeled MTD and concrete strength ranges for three different pavement alignments:

- 2-lane mainline
- 1-lane mainline
- 16-ft wide ramp configuration

Figure 34, Figure 35, and Figure 36 show these three configurations, along with the maximum possible offset, given a nominal 10-ft wide MTD. The free edge from which the offset is measured is defined as a longitudinal concrete pavement joint not tied to a concrete pavement lane, shoulder, moment slab, or other structures.

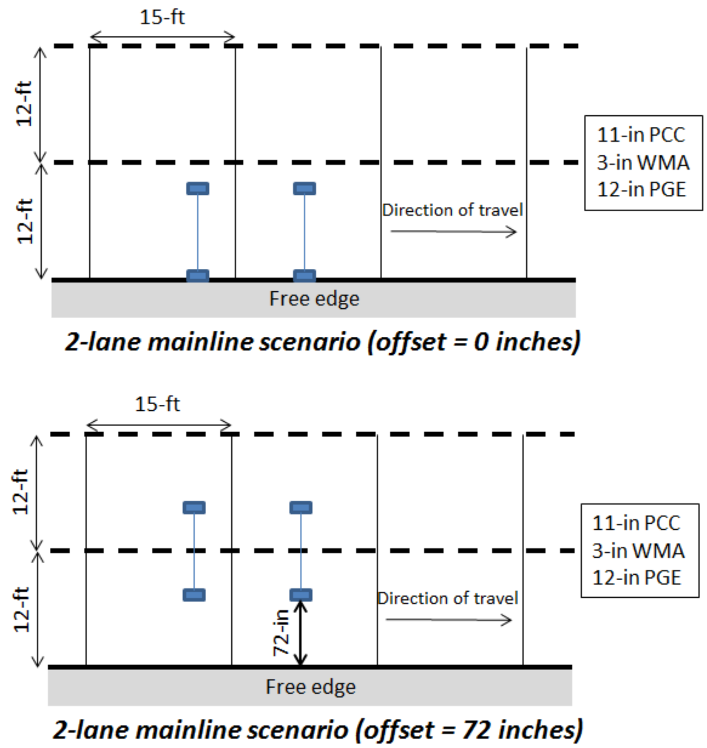


Figure 34. 2-lane mainline configuration with zero and maximum offset.

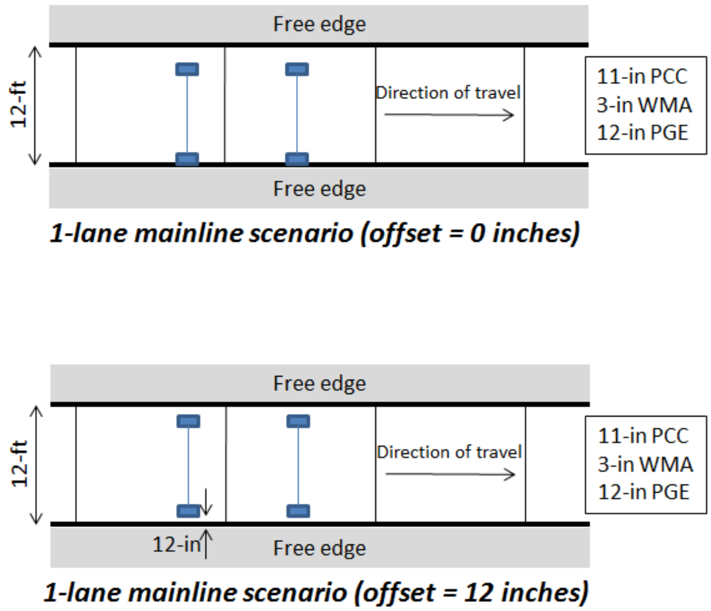


Figure 35. 1-lane mainline configuration with zero and maximum offset.

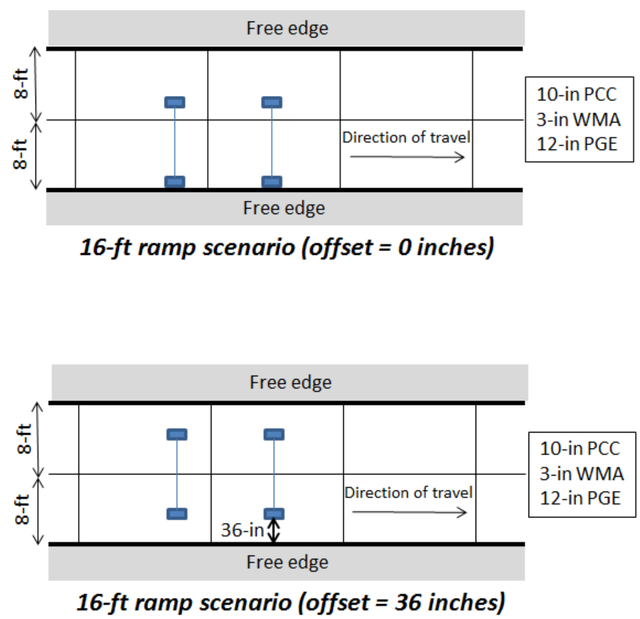


Figure 36. 16-ft ramp configuration with zero and maximum offset.

4.1.4 Material Transfer Devices

The Tollway modeled six different MTDs, including:

- RoadTec 2500
- RoadTec 1500
- Ingersoll Rand MC 330
- Weiler E1250B

- Vögele MT-3000-2i
- Cedar Rapids CR662RM

Total loaded weights and wheel/axle or track dimensions for each MTD evaluated are provided in the following section. Combinations of offset from free edge and concrete strength where each MTD can be safely used are also provided.

4.1.5 I-SLAB Details

Additional information used as inputs for the I-SLAB runs included:

JPCP Layer

Thickness – 10.0 and 11.0 inches

E_{PCC} – 3.3 Mpsi (f_c = 3000 psi) to 4.7 Mpsi (f_c = 6000 psi)

WMA Stabilized Subbase Layer

Thickness – 3.0 inches

E_{AC} – 400 ksi

Granular Base Layer

Thickness – 12.0 inches

E_{GB} – 50 ksi

Subgrade Layer

k = 150 psi/in

4.1.6 I-SLAB Results

The results of the I-SLAB MTD modeling are provided for each MTD considered. For each device and pavement configuration, a table of acceptable combinations of concrete strength and offset is provided, as indicated by a Yes.

4.1.7 Additional Devices

In the event that MTDs beyond those evaluated in this document are proposed in the future, additional analysis will be performed to determine the acceptable combinations of concrete strength and offset for those devices.

The Tollway also evaluated two asphalt pavers (track mounted and rubber tire mounted) to determine their potential for damaging new JPCP. Those results are included in the following section.

4.2 MTD Specific Guidelines

4.2.1 RoadTec 2500

Allowable scenarios for 2-lane mainline alignment

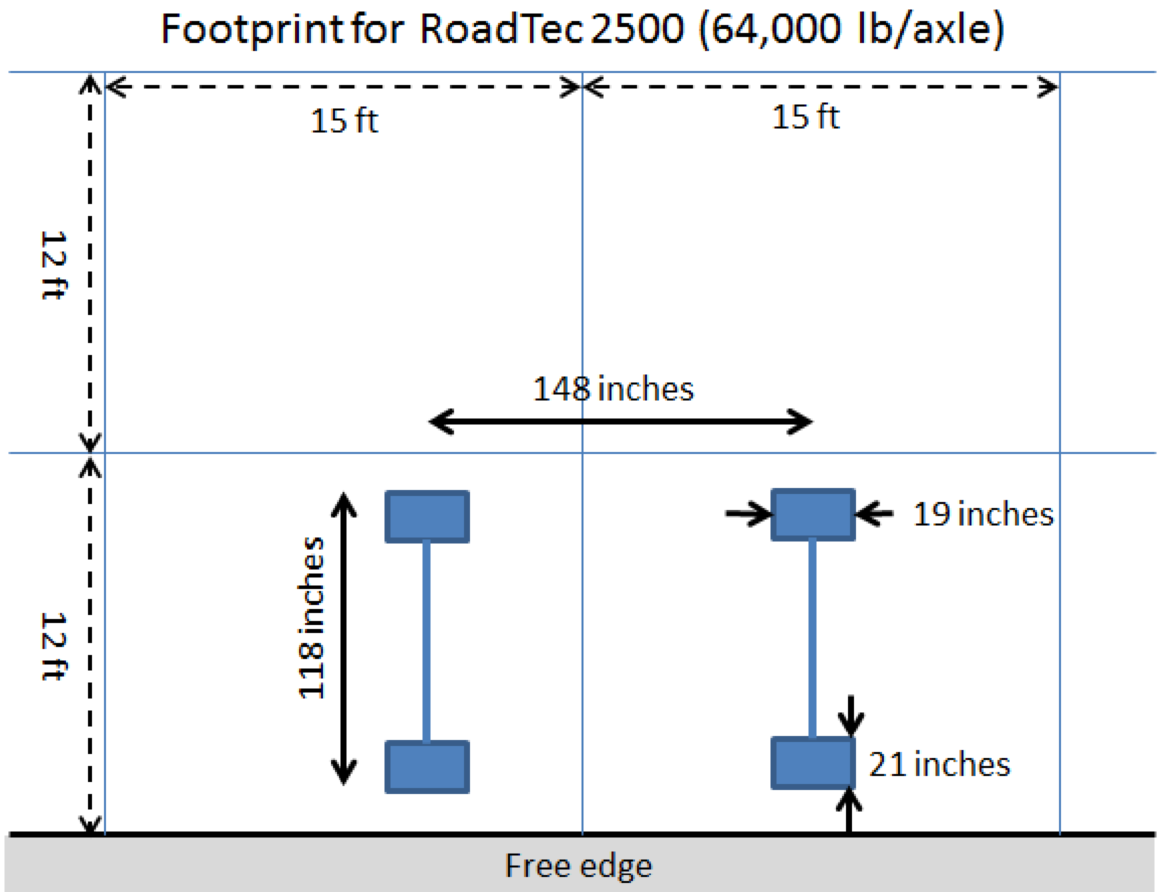
PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500						Yes	Yes
4000					Yes	Yes	Yes
5000				Yes	Yes	Yes	Yes
6000			Yes	Yes	Yes	Yes	Yes

Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				
4000				
5000				
6000				Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		
6000		


Footprint for RoadTec 2500 (64,000 lb/axle)
15 ft
15 ft
12 ft
12 ft
148 inches
118 inches
19 inches
21 inches
Free edge

SPECIFICATIONS

ENGINE
- SB-2500e:Tier 4F; Cummins® QSL9 300 hp (224 kW) @ 2,000 rpm
- SB-2500ex: Tier 3; Cummins® QSL9 300 hp (224 kW) @ 2,000 rpm*

** ex machines for lesser regulated countries*

COOLING SYSTEM
- Quiet operation, dual, variable speed hydraulically driven fans

WEIGHT
- 77,240 lbs (35,035 kg)

CONSTRUCTION
- Stability without unnecessary weight
- Heavy duty conveyor flights and chain
- Replaceable wear plate in all high wear areas

ELECTRICAL SYSTEM
- Two 4D batteries & 95 amp alternator
- 24v system with master disconnect switches.
- Electric-over-hydraulic solenoids with manual override

PROPEL SYSTEM
- Hydrostatic drive with continuously variable speed control with two speed ranges
- Front-wheel steer

SPEED
- Working: 0-3.0 mph (0-4.8 kph)
- Travel: 0-9 mph (0-14.5 kph)

BRAKE SYSTEM
- Hydrodynamic disc caliper brakes, and parking brake

TIRES
- 21" (533 mm) wide x 25" (635 mm) interior diameter high-flotation tires

OPERATOR STATIONS
- Two operator stations (left & right side) with deluxe adjustable seats
- Operator stations can slide 16" (400 mm) out past edge of machine for visibility
- Center control console pivots to right or left

GROUND CONTROLS
- (2) front dump hopper control boxes

FUME EXTRACTION SYSTEM
- Clearview FXS® system with dual fans to draw fumes away from operator

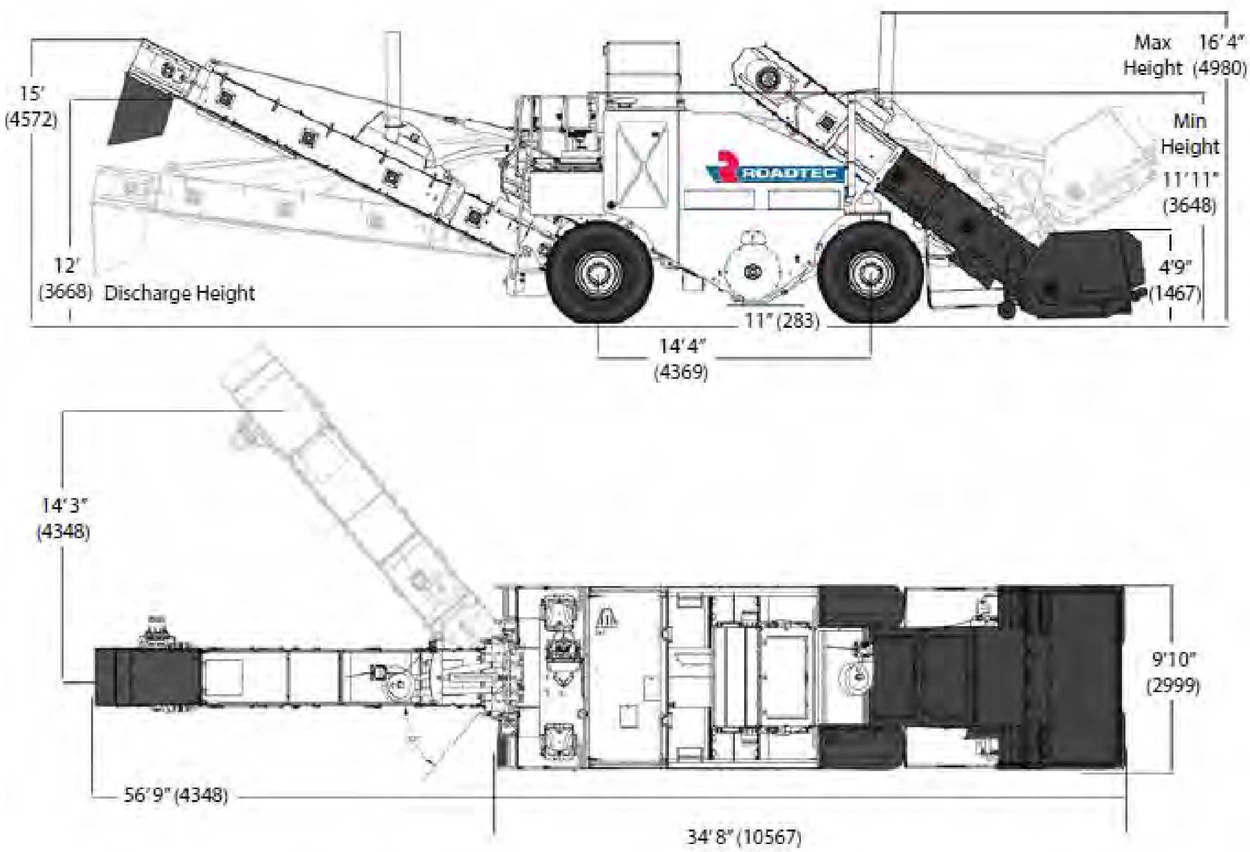
TRUCK DUMP HOPPER
- Front hopper has swivel support casters. Vibrating floor plate. 9'2" (2,794 mm) wide truck opening
- Adjustable width option available
- Hydraulic, adjustable push rollers
- Hydraulic front hopper baffle adjustable for optimal material flow
- 29" (737 mm) o.d. cast, ni-hard, segmented auger

DUMP HOPPER UNLOADING CONVEYOR (C1)
- Drag conveyor with 1,000 tph (907 mtph) capacity
- Dual roller bushing offset link chain
- Conveyor floors lined with replaceable chrome-carbide clad wear plates

SURGE BIN & REMIXING AUGER
- 25 tons (22.7 mt) storage capacity.
- 29" (737 mm) o.d. cast, ni-hard, variable triple pitch augers
- Drag conveyor with 600 tph (544 mtph) capacity
- Dual roller bushing offset link chain
- Conveyor floors lined with replaceable chrome-carbide clad wear plates

PAVER LOADING CONVEYOR (C3)
- Drag conveyor with 600 tph (544 mtph) capacity
- Dual roller bushing offset link chain
- Conveyor floors made of chromium carbide clad plate
- Insulated conveyor floor
- Controls interlock with surge bin unloading conveyor
- Conveyor can be positioned up to 50° to either side of center
- Conveyor guard rails

SERVICE CAPACITIES
- Fuel Tank .... 150 gal (568 l)
- Hydraulic Fluid Tank.......... 96 gal (363 l)



Dimensions in parentheses are mm.

Specifications are subject to change without notice.

4.2.2 RoadTec 1500

Allowable scenarios for 2-lane mainline alignment

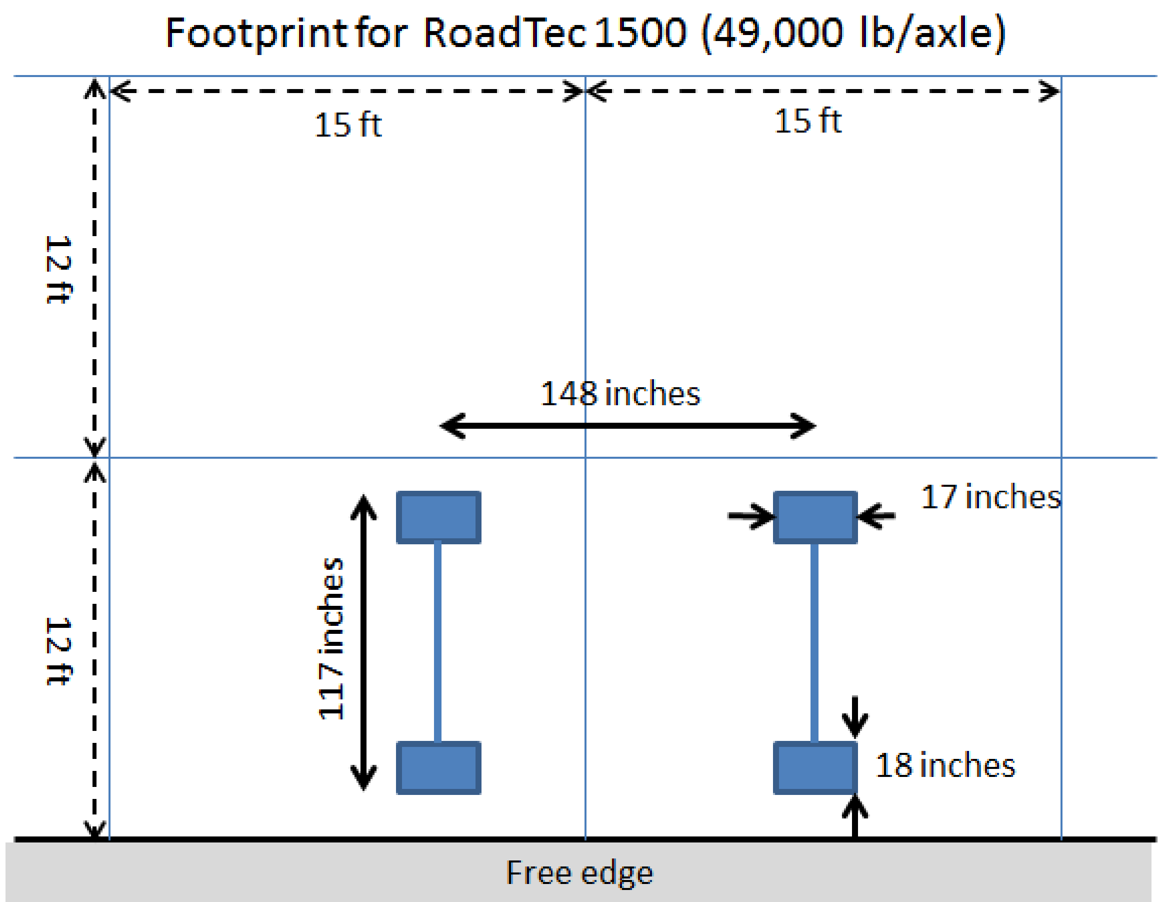
PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500					Yes	Yes	Yes
4000				Yes	Yes	Yes	Yes
5000		Yes	Yes	Yes	Yes	Yes	Yes
6000		Yes	Yes	Yes	Yes	Yes	Yes

Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				
4000				
5000				Yes
6000			Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		Yes
6000		Yes


Footprint for RoadTec 1500 (49,000 lb/axle)
15 ft
15 ft
12 ft
12 ft
148 inches
17 inches
117 inches
18 inches
Free edge

SPECIFICATIONS

ENGINE
- Tier 3, Caterpillar® C9 300 hp (224 kW) @ 2,200 rpm

WEIGHT
- 67,240 lbs (30,500 kg)

COOLING SYSTEM
- Dual, quiet operation fans

ELECTRICAL SYSTEM
- Two 4D batteries & 115 amp alternator
- 12v system with master disconnect switches.
- Electric-over-hydraulic solenoids with manual override.

PROPEL SYSTEM
- Hydrostatic drive
- Continuously variable speed control with two speed ranges.

SPEED
- Working: 0-2.8 mph (0-4.5 kph)
- Travel: 0-11.4 mph (0-18.4 kph)

BRAKE SYSTEM
- Hydrodynamic disc caliper brakes, and parking brake

TIRES
- Large, high-flotation - 18" x 25" (457 mm x 635 mm)

OPERATOR STATIONS
- Two operator stations with deluxe adjustable seats.
- Center control console pivots to right or left

GROUND CONTROLS
- (2) front dump hopper control boxes

FUME EXTRACTION SYSTEM
- Two blowers. Fold-down 10" (254 mm) exhaust pipes

TRUCK DUMP HOPPER
- Front hopper has swivel support casters. Vibrating floor plate. 9'2" (2,794 mm) wide truck opening
- Hydraulic, adjustable push rollers.
- Hydraulic hopper baffle adjustable for optimal material flow.

DUMP HOPPER TRANSVERSE AUGER
- 22" (559 mm) o.d. cast, segmented auger.

DUMP HOPPER UNLOADING CONVEYOR (C1)
- Drag conveyor with 600 tph (544 mtph) capacity.
- Dual roller bushing chain.
- Weld-on flights 5/8" (16 mm) thick, 5 9/16" (142 mm) wide x 33 3/4" (857 mm) long. Ni-Hard liner plates.

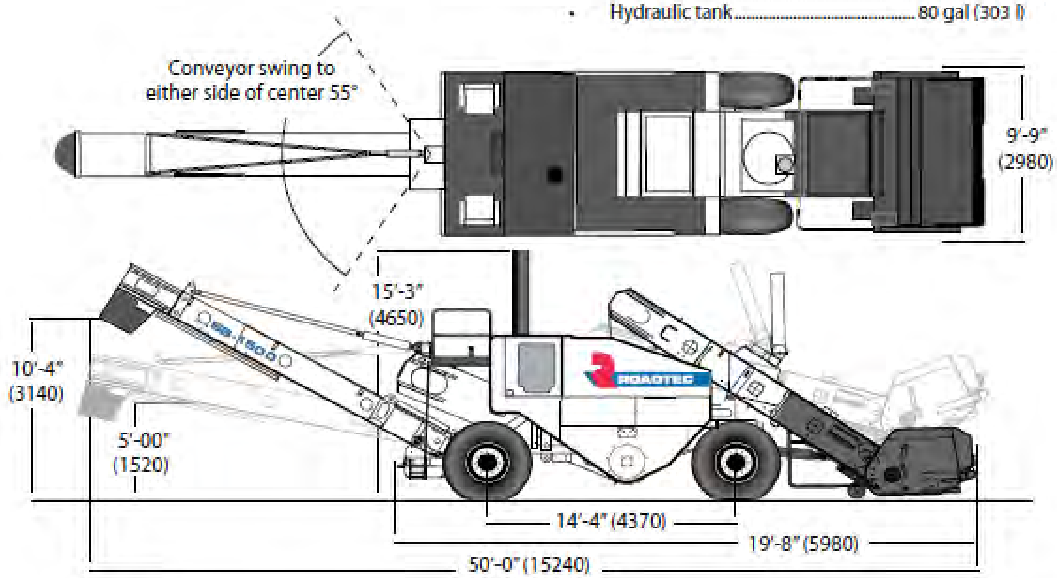
SURGE BIN
- 15 tons (13.6 mt) storage capacity.

REMIXING AUGER IN SURGE BIN
- 22" (559 mm) o.d. cast, segmented augers

SURGE BIN UNLOADING CONVEYOR (C2)
- Drag conveyor with 600 tph (544 mtph) capacity.
- Dual roller bushing chain.
- Weld-on flights 5/8" (16 mm) thick, 7" (178 mm) wide x 35 1/2 (902 mm) long. Ni-Hard liner plates are replaceable.

PAVER LOADING CONVEYOR (C3)
- Drag conveyor with 600 tph (544 mtph) capacity.
- Dual roller bushing chain.
- Conveyor flights welded to the chain are 1/2" (12.7 mm) thick, 4 3/4" (121 mm) wide and 30" (762 mm) long Conveyor has bolted 1/2" (12.7 mm) AR500 replaceable floor plates and doors.
- Controls interlock with surge bin unloading conveyor.

SERVICE CAPACITIES
- Fuel tank .... 110 gal (416 l)
- Hopper .... 15 tons (13.6 mt)
- Material .... 110 lbs/cu ft (1,762 kg/cu m)
- Hydraulic tank .... 80 gal (303 l)



Dimensions in brackets are mm.

Specifications are subject to change without notice.

4.2.3 Ingersoll Rand MC 330

Allowable scenarios for 2-lane mainline alignment

PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500						Yes	Yes
4000					Yes	Yes	Yes
5000		Yes	Yes	Yes	Yes	Yes	Yes
6000		Yes	Yes	Yes	Yes	Yes	Yes

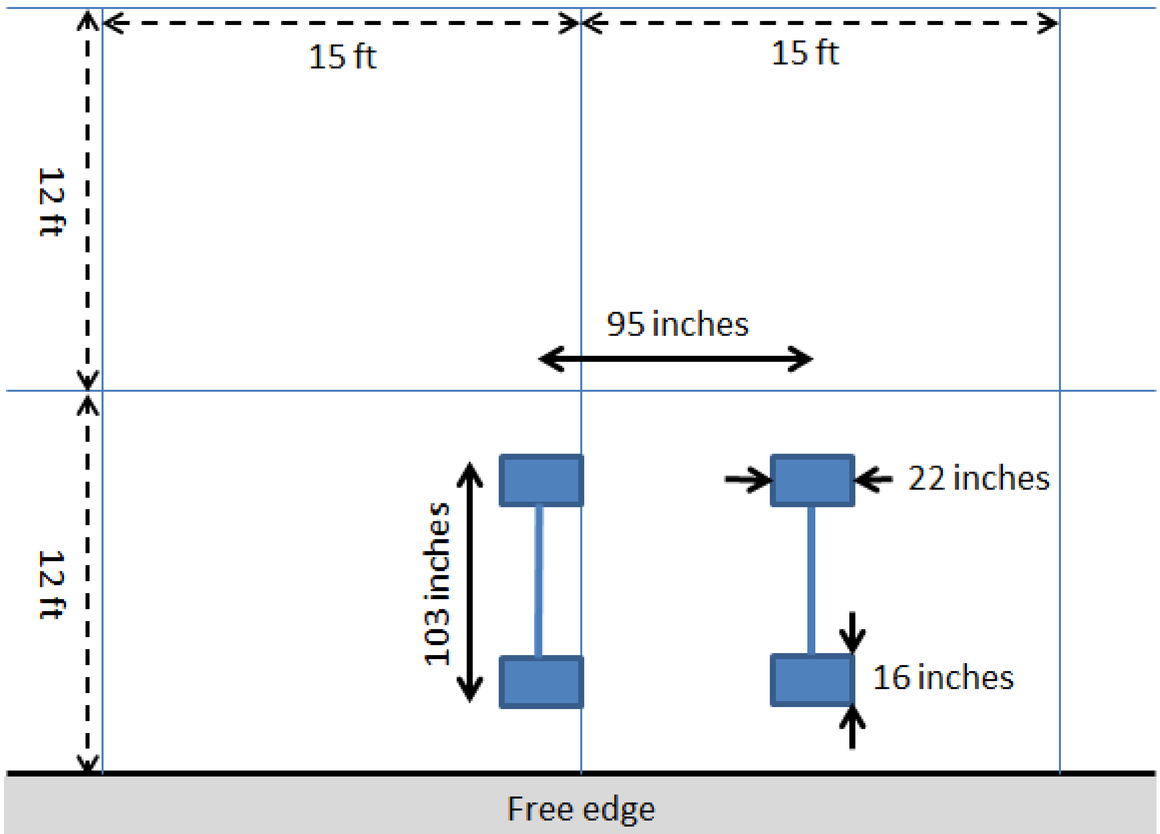
Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				
4000				
5000				Yes
6000			Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		Yes
6000		Yes

Footprint for MC330 (56,950 lb/axle)



TRANSVERSE AUGER TUB	
Weight (empty) – lb (kg)	4,200 (1905)
Volume Capacity – T (t)	3.5 (3.18)
SWING CONVEYOR	
Weight (empty) – lb (kg)	14,500 (6578)
Offset Discharge Angle	+/- 90°
Discharge Reach @ 90° Offset – ft (m)	12' (3.65)
Transport Length – ft (m)	22' 8" (6.9)
Transport Height – in (mm)	97" (2464)
Transport Width – in (mm)	102.7" (2608)
Belt Width – in (mm)	48" / effective 36" (1219 / effective 914.9)

SELECTED OPTIONS (FIELD-INSTALLED)

- Additional operator's umbrella
- Discharge position sensor
- Generator set
- Swing conveyor for MC-330, installation kit, and discharge chute
- Twin auger tub insert (includes hose kit)
- Truck hitch

MODEL	MC-330	MC-330 W/OPTIONAL SWING CONVEYOR
WEIGHT & DIMENSIONS		
Weight – lbs (kg)	45,000 (20411)	60,900 (27623)
Width (wings down) – ft (m)	10.1 (3.08)	10.1 (3.08)
Width (wings up) – ft (m)	10.3 (3.15)	10.3 (3.15)
Length – ft (m)	40 (12.19)	56.8 (17.32)
Height (w/o upper conveyor sides) – ft (m)	10.75 (3.28)	10.75 (3.28)
Height (w/ upper conveyor sides) – ft (m)	12.33 (3.76)	12.33 (3.76)
Discharge Height – ft (m)	6.42 (1.96)	10.75 (3.08)
Gauge Width (center to center of drive wheels) – in (mm)	95 (2413)	95 (2413)
Wheelbase – in (mm)	256 (6502)	256 (6502)
Turning Radius (inside) – ft (m)	34.33 (9.85)	34.33 (9.85)
Loading Ramp Angle	12°	12°
Volume Capacity – ton (T) / cu ft (m³)	30 / 225 (33.5 / 6.4)	30 / 225 (33.5 / 6.4)
PROPULSION		
Drive Tire	16:00 x 24, G2 radial tires	16:00 x 24, G2 radial tires
Front Wheel	14" x 22" solid rubber tired wheels	14" x 22" solid rubber tired wheels
Traction Drive	3-speed reduction transmission, 2-speed differential axle	
Type System	Electrically controlled hydrostatic drive	
OPERATING SPEED		
Low Range Low / High Axle – fpm (m/min)	0 – 141 (0 – 43) / 0 – 196 (0 – 59.8)	0 – 141 (0 – 43) / 0 – 196 (0 – 59.8)
Mid Range Low / High Axle – fpm (m/min)	0 – 294 (0 – 89.6) / 0 – 409 (0 – 124.7)	0 – 294 (0 – 89.6) / 0 – 409 (0 – 124.7)
High Range Low / High Axle – mph (km/h)	0 – 10.7 (0 – 17.1) / 0 – 14.8 (0 – 23.8)	0 – 10.7 (0 – 17.1) / 0 – 14.8 (0 – 23.8)
Reverse	Full reverse in any of the 6-speed ranges	
ENGINE		
Make & Model	Cummins Elite 6BTA5.9-C174	Cummins Elite 6BTA5.9-C174
Type	Tier II diesel	Tier II diesel
Rated Power @ 2,100 rpm – hp (kW)	184 (137)	184 (137)
BRAKES		
Service	Dynamic hydrostatic through propulsion system	
Secondary	Hand-actuated, hydraulic caliper / disc brake	
Parking	Independent spring applied, hydraulic release	
ELECTRICAL		
Electrical	12 V, negative ground, (1) 1,150 CCA battery	12 V, negative ground, (1) 1,150 CCA battery
Alternator	130 amps	130 amps
MISCELLANEOUS		
Fuel Capacity – gal (L)	50 (189.3)	50 (189.3)
Hydraulic Oil Capacity – gal (L)	42 (159)	42 (159)
Cooling System – qt (L)	26 (25)	26 (25)

4.2.4 Weiler E1250B

Allowable scenarios for 2-lane mainline alignment

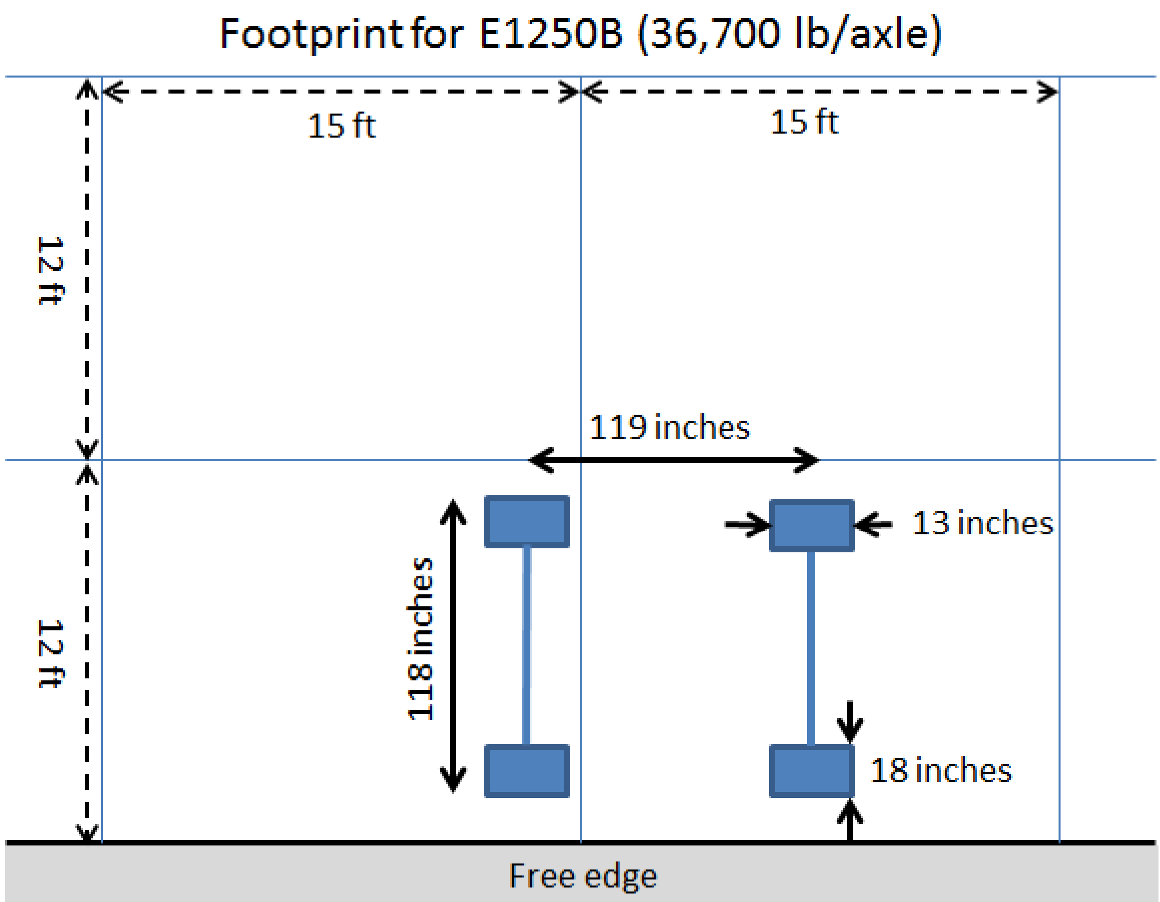
PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500		Yes	Yes	Yes	Yes	Yes	Yes
4000		Yes	Yes	Yes	Yes	Yes	Yes
5000	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6000	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500		Yes	Yes	Yes
4000		Yes	Yes	Yes
5000		Yes	Yes	Yes
6000		Yes	Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		Yes
4000		Yes
5000	Yes	Yes
6000	Yes	Yes


Footprint for E1250B (36,700 lb/axle)
15 ft
15 ft
12 ft
12 ft
119 inches
118 inches
13 inches
18 inches
Free edge

E1250B SPECIFICATIONS

WEIGHT	53,400 lb	24 222 kg
TRANSPORT HEIGHT	11' 5"	3505 mm
TRANSPORT LENGTH	43' 7"	13 284 mm
TRANSPORT WIDTH	9' 10"	2997 mm
WORKING HEIGHT	12' 6"	3810 mm
ENGINE	Cat® C7.1 Tier 4	
HORSEPOWER	250 hp	168 kW

TRANSPORT SPEED (MAX)	9.8 mph	15.8 km/hr
WORKING SPEED	202 fpm	61 mpm
CONVEYOR CAPACITY	600 tph	544 mtph
CONVEYOR SLAT WIDTH	36"	914 mm
ELEVATOR CAPACITY	600 tph	544 mtph
ELEVATOR SLAT WIDTH	56"	1,422 mm
FUEL TANK CAPACITY	130 gal	492 L

HYDRAULIC TANK CAPACITY	86 gal	325 L
TURNING RADIUS	19'	5.8 m
TIRES	High Flotation 17.5"-25" 20 ply	
GROUND DRIVE	4 Wheel Hydrostatic w/ 3 Speeds	

POWERTRAIN

Cat® C7.1 Tier 4 Engine with 250 hp (168 kW)
4-wheel drive
Shift-on-the-fly 3-speed hydrostatic drive
202 fpm (61 mpm) working speed
9.8 mph (15.8 km/hr) transport speed
2-wheel steering w/ 19' (5.8 m) turning radius

OPERATING ENVIRONMENT

24" (610 mm) sliding operator platform
High-back, heated suspension seat w/ 357° rotation
Convenient control locations on single panel
Dual side dump hopper control stations
Rear control station for cleanout and hopper insert placement
Digital controller for system calibrations
Optional paver hopper insert management system
Optional distance to paver control

MATERIAL DELIVERY

600 tph (544 mtph) elevator capacity
600 tph (544 mtph) discharge conveyor capacity
Variable speed elevator and conveyor
Dump-Assist hydraulic moving floor
Auto dump hopper cycle
Heavy-duty, cast dump hopper augers
Patented twin-interlaced auger remix
High torque, direct-drive motors
10' 2" (3.1 m) max conveyor swing in either direction
Windrow head attachment option

CLEANOUT

Full-width, hydraulic cleanout doors on elevator/conveyors
Full-width dump hopper cleanout door
Two hydraulic remix chamber cleanout doors
Optional internal spray down system

SERVICE/MAINTENANCE

Hydraulic conveyor chain tensioner
Chromium carbide wear plate below conveyor foot shaft
Separated foot shaft bearings
Two large engine access doors
Easily accessible battery compartment
Braided electrical harnesses and sealed connections
Color-coded electrical wires
Optional auto greaser system

REQUIRED OPTION

Remix system

OPTIONAL EQUIPMENT

Truck hitch
Windrow head in addition to truck dump hopper
Canopy
Chromium carbide floor plates
Separate 60 gal (227 L) tank for tire spray system
Chain and sprocket internal spray down system
Tire spray system
LED work lights (2 head, 6 work, 2 ground and strobe)
LED blade lights
Truck signal lights
12kW generator
Paver hopper management with distance to paver
Camera system w/ 7" (178 mm) color display & 4 cameras
Automatic greaser - 40 points
13 ton (11.8 mt) hopper insert
5 ton (4.5 mt) or 8 ton (7.2 mt) hopper insert extension

4.2.5 Vögele MT-3000-2i

Allowable scenarios for 2-lane mainline alignment

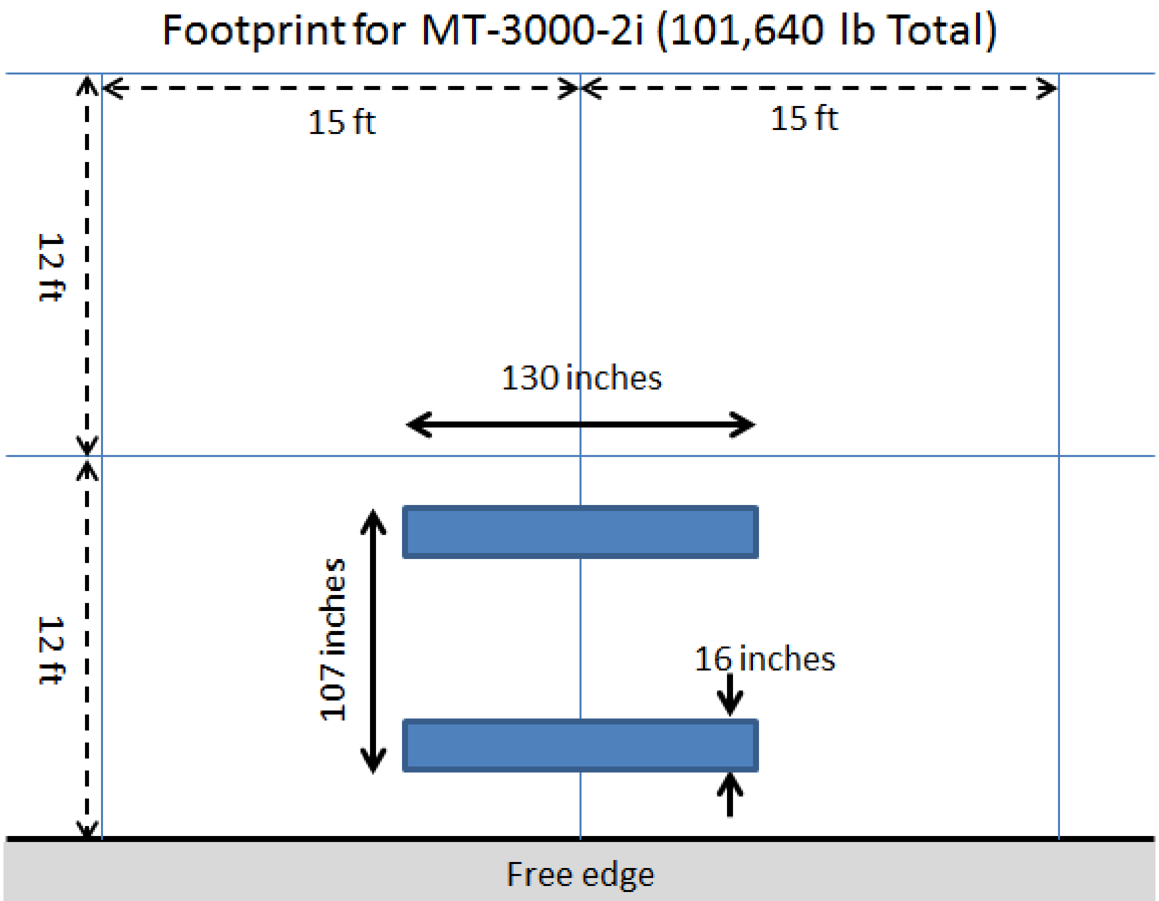
PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500				Yes	Yes	Yes	Yes
4000				Yes	Yes	Yes	Yes
5000			Yes	Yes	Yes	Yes	Yes
6000		Yes	Yes	Yes	Yes	Yes	Yes

Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				
4000				Yes
5000				Yes
6000			Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		
6000		Yes


Footprint for MT-3000-2i (101,640 lb Total)
15 ft
15 ft
12 ft
12 ft
130 inches
107 inches
16 inches
Free edge

Power unit	
Engine	6-cylinder diesel engine, liquid-cooled
Manufacturer	Deutz
Type	TCD 6.1 L6
Output	
Nominal	160kW at 2,000rpm (according to DIN)
ECO mode	150kW at 1,800rpm
Exhaust emissions standard	EU Stage 4, US EPA Tier 4f
Exhaust gas aftertreatment	DOC, DPF, SCR
Emission data	
Sound power level	≤ 108dB(A)
Daily noise exposure level	> 80dB(A)
Fuel tank	450 litres

Undercarriage	
Crawler tracks	provided with rubber pads
Ground contact	3,060 x 305mm
Traction drive	separate hydraulic drive and electronic control provided for each crawler track
Speeds	
Operating	up to 25m/min., infinitely variable
Travel	up to 4.5km/h, infinitely variable
Steering	by alteration of track running speeds
Brake	multiple-disk brake locked on automatically without oil pressure

Material conveying systems	
Transverse augers	2, installed in the receiving hopper
Standard	cylindrical augers
Diameter	400mm
Optional	conical augers for homogenization of the material
Drive	separate hydraulic drive
Speed	79rpm
Conveyors	2 continuous rubber conveyor belts
Drive	separate hydraulic drive
Belt width	1,100mm
Heating	infrared heating panels, diesel-powered
Pivoting conveyor	hydraulically pivoting
Pivoting angle	55° to the left or right
Reach	3,500mm (outside edge of feeder to centre of discharge point)
Transfer height (max)	3,900mm
Conveying capacity (max)	1,200t/h*

Receiving hopper	
Holding capacity	16.4t
Width	3,680mm (hopper sides extended)
Feed height	600mm (bottom of receiving hopper)
Push-rollers	oscillating

Extra material hopper	
Holding capacity	20-24t (to be placed into the material hopper of the paver)

Dimensions (transport) and weight	
Length	14,820mm
Width	3,000mm
Height	3,100mm
Weight	23.8t

4.2.6 Cedar Rapids CR662RM

Allowable scenarios for 2-lane mainline alignment

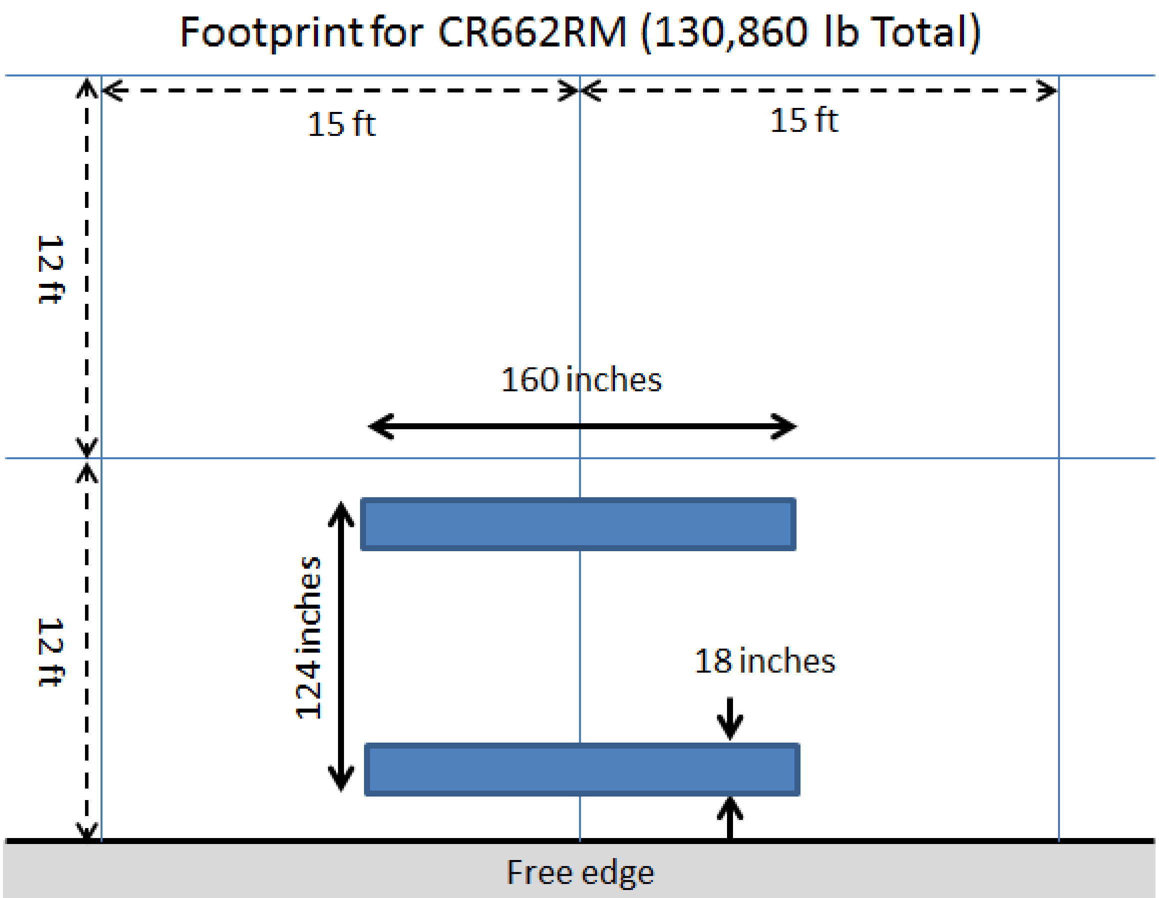
PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500				Yes	Yes	Yes	Yes
4000				Yes	Yes	Yes	Yes
5000		Yes	Yes	Yes	Yes	Yes	Yes
6000		Yes	Yes	Yes	Yes	Yes	Yes

Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				Yes
4000				Yes
5000				Yes
6000			Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		Yes
6000		Yes


Footprint for CR662RM (130,860 lb Total)
15 ft
15 ft
12 ft
12 ft
160 inches
124 inches
18 inches
Free edge

Technical Specifications
Cedarapids CR662RM

Standard Equipment
- ☑ Turbocharged 260 hp Tier 4 final engine
- ☑ Power-tilt hood with radiator
- ☑ Patented Remix Anti-Segregation System
- ☑ Lockout/tagout capable E-stop and master electrical switch
- ☑ Fume-recovery system
- ☑ Accessible filter locations
- ☑ All-welded mainframe construction
- ☑ Adjustable spreading auger height
- ☑ Outboard spreading auger drive
- ☑ Front gear box remix auger drive
- ☑ Independently controlled delivery and spreading augers
- ☑ Reinforced, sealed, tilting hopper wings with beveled corners
- ☑ Hydraulically adjustable screed vibrators
- ☑ Hydraulic power crown control
- ☑ Adjustable material retaining plates
- ☑ Smartrac self-tensioning track system
- ☑ Wide stance improves maneuverability
- ☑ Crawler-mounted Three-Point suspension
- ☑ Oscillating bogie wheel assemblies
- ☑ Independent hydrostatic drive for each track
- ☑ Replaceable rubber tracks
- ☑ De-tracking warning light
- ☑ Electric-over-hydraulic steering wheel control
- ☑ Operator's umbrella
- ☑ 30 ft hose reel for spray-down
- ☑ Back-up alarm

Mandatory Options (Select only one)
- ☑ Oscillating push rollers or Truck hitch

Optional Paver Equipment
- ☐ Stretch® 20 screed with electric or oil heat
- ☐ Fastach® 10 screed with electric or oil heat
- ☐ Grade and slope control
- ☐ Multi-foot grade reference system
- ☐ Sonic averaging systems
- ☐ Bevel guide plates
- ☐ Cutoff shoes, 12" and 24" sections
- ☐ 500-hour filter kit
- ☐ Screed extensions
- ☐ Up time kit

Optional MTV Equipment
- ☐ 6 kW generator
- ☐ 34 kW generator (Stretch® 20 screed)
- ☐ Hopper insert
- ☐ Longer swing conveyor with counter weight - 52" (1321 mm)

www.bomag.com/us

Technical Data		BOMAG CR662RM
Paver		
Paver width	in (mm)	124 (3150)
Paving width (max)	ft (m)	30 (9.1)
MTV width	in (mm)	128 (3250)
Paving depth (max)	in (mm)	12 (305)
Paving speed (max)	ft/min (m/min)	225 (68.6)
Travel speed (max)	mph (kmph)	9.6 (15.5)
Rubber Belt Track	in (mm)	18 x 160 (457 x 4064)
Brakes		multiple disc parking
Weights*		
Tractor	lbs (kg)	36200 (16420)
with Fastach® 10	lbs (kg)	40200 (18234)
with Stretch® 20	lbs (kg)	44100 (20003)
with standard conveyor	lbs (kg)	54860 (24884)
Engine		
Make/Model		Cummins
Type		QSB6.7
Tier Compliance		Tier 4f
Performance	hp (kW)	260 (194)
Speed	rpm	2200
Electrical	V	12
Capacities		
Diesel fuel	gal (l)	72 (273)
Hydraulic oil	gal (l)	75 (284)
Cooling system	gal (l)	6.5 (25)
Spreading Auger Sections		
Construction		Cast, high alloy
Diameter	in (mm)	16 (406)
Thickness	in (mm)	0.625 (16)
Hopper		
Length and width	in (mm)	90 (2286) x 119 (3013)
Volume	ft^3 (m^3)	267 (7.56)
Capacity	tons (tonnes)	16.7 (15)*
Capacity (Hopper + Conveyors)	tons (tonnes)	38 (34.5)*
Surge capacity with hopper insert	tons (tonnes)	43 (39)*
Feed tunnel width (each)	in (mm)	30 (762)
Remix augers (diameter)	in (mm)	12 (305)
Auger thickness	in (mm)	0.625 (16)
Trough liner thickness	in (mm)	0.375 (9.5)
Screed		
Screed plate thickness	in (mm)	0.5 (12.7)
Positive crown (hydraulically powered)	in (mm)	3 (76)
Negative crown (hydraulically powered)	in (mm)	1 (25)
Vibrations per minute (max)		3000
Screed Heaters		
Stretch® 20 (electric heat) generator	kW	34
Stretch® 20 (four oil heaters) 274000 BTU (total)	gph (lph)	2 (7.6)
Fastach® 10 (electric heat) generator	kW	34
Fastach® 10 (two oil heaters) 178000 BTU (total)	gph (lph)	1.3 (4.9)

Technical modifications reserved. Machines may be shown with options. Weights are based on average shipping weights.
* Based on material density of 125 lb/ft³ (2002 kg/m³)

BOMAG FAYAT GROUP

BOMAG Americas, Inc.
125 Blue Granite Parkway
Ridgeway, SC 29130 · Tel: 803 337-0700

4.2.7 Vögele VISION 5200-2

Allowable scenarios for 2-lane mainline alignment

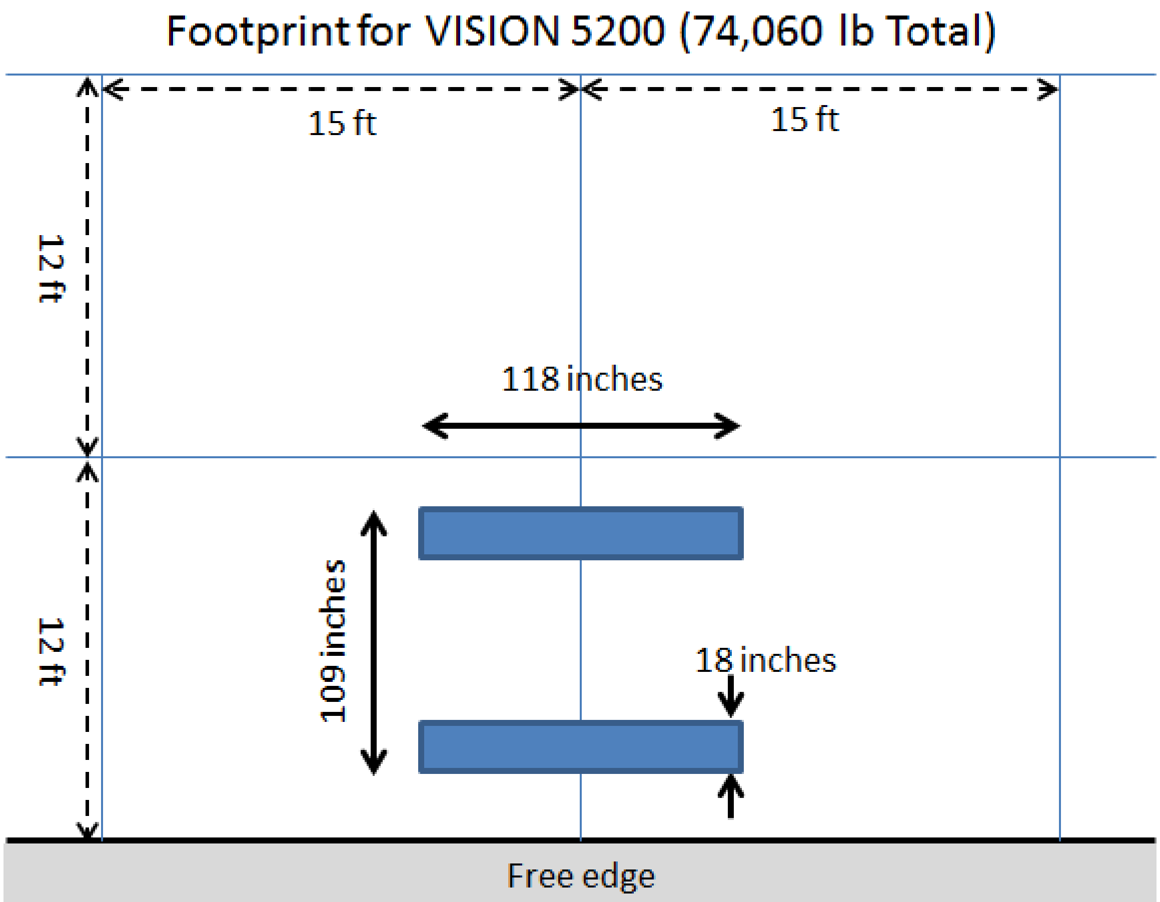
PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500			Yes	Yes	Yes	Yes	Yes
4000			Yes	Yes	Yes	Yes	Yes
5000		Yes	Yes	Yes	Yes	Yes	Yes
6000		Yes	Yes	Yes	Yes	Yes	Yes

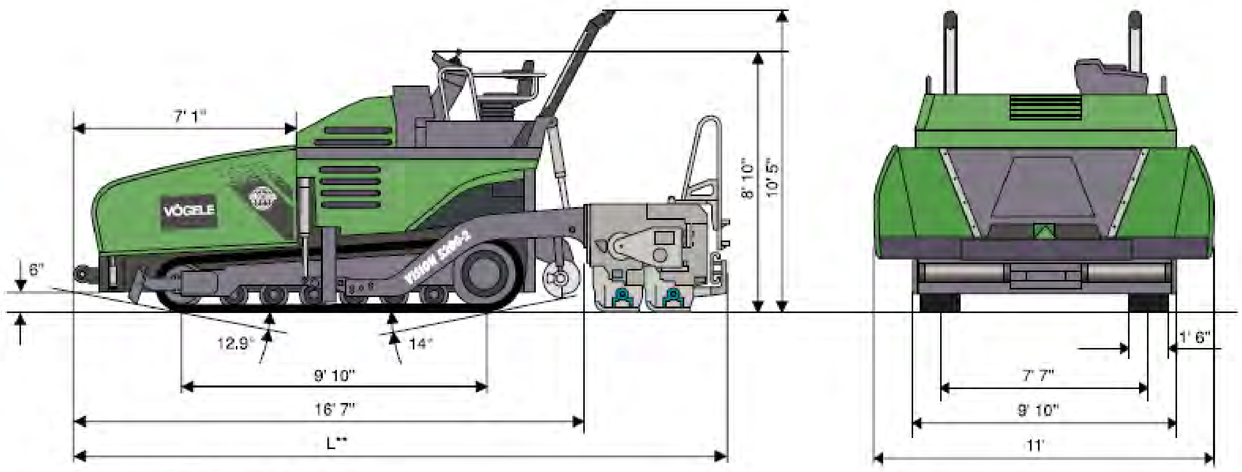
Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				Yes
4000			Yes	Yes
5000			Yes	Yes
6000		Yes	Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		Yes
6000		Yes


Footprint for VISION 5200 (74,060 lb Total)
15 ft
15 ft
12 ft
118 inches
12 ft
109 inches
18 inches
Free edge



L** = Dependent on Screed Type (see Specification)

Power Unit	
Engine:	6-cylinder CUMMINS diesel engine, liquid-cooled
Type:	QSB 6.7 C-240
Output:	Nominal: 240 h.p. at 2,000 rpm
	ECO Mode: 231 h.p. at 1,800 rpm
Fuel Tank:	106 gal. (US)
Electrical System:	24 V
Undercarriage	
Crawler Tracks:	continuous rubber band
Ground Contact:	9 ft. 10 in. x 1 ft. 6 in.
Suspension:	track carriers mounted on bogies
Track Tensioning:	automatic (hydraulic)
Track Rollers:	lifetime grease lubricated
Traction Drive:	separate hydraulic drive and electronic control provided for each crawler track
Speeds:	- Paving: up to 250 fpm, infinitely variable
	- Travel: up to 7.5 mph, infinitely variable
Steering:	by alteration of track running speeds
Service Brake:	hydrostatic
Parking Brake:	spring-loaded multiple-disk brake, maintenance-free
Material Hopper	
Hopper Capacity:	240 cu. ft. (31,400 lbs.) including conveyor tunnel
Width:	11 ft.
Dump Height:	24 in. (bottom of material hopper)
Push-Rollers:	oscillating, displaceable forwards by 2 in., 4 in. and 6 in.
Conveyors and Augers	
Conveyors:	2, with replaceable feeder bars, conveyor movement reversible for a short time
	Drive: separate hydraulic drive provided for each conveyor
	Speed: up to 102 fpm, infinitely variable
	(manual or automatic)

Augers:	2, with exchangeable auger flights, auger rotation reversible
	Diameter: 16 in.
	Drive: separate hydraulic drive provided for each auger
	Speed: up to 131 rpm, infinitely variable
	(manual or automatic)
	Auger Height: infinitely variable by 6 in., hydraulic
Lubrication:	Centralized lubrication system, electrically driven grease pump (optional)
Screed Options	
VR 600-2:	basic width 10 ft., infinitely variable range 10 ft. to 19 ft. 8 in.
	maximum width 28 ft.
Carlson EZ III-1017:	basic width 10 ft., infinitely variable range 10 ft. to 17 ft.
	maximum width 24 ft.*
Carlson EZ IV-1019:	basic width 10 ft., infinitely variable range 10 ft. to 19 ft.
	maximum width 25 ft.
Screed Version:	V
Layer Thickness:	up to 12 in.
Screed Heating:	electric by heating rods
Power Supply:	three-phase A.C. generator
Dimensions and Weights	
Length:	Tractor Unit and Screed in Transport Position
	- VR 600-2: 21 ft. 7 in.
	- Carlson EZ III-1017 / EZ IV-1019: 20 ft. 9 in.
Weights:	Tractor Unit: 34,390 lbs.
	- VR 600-2: 8,270 lbs.
	- Carlson EZ III-1017: 6,000 lbs.
	- Carlson EZ IV-1019: 7,000 lbs.
Optional Equipment	
	NIVELTRONIC Plus® for Automatic Grade and Slope Control (various grade sensors available). Separate washdown tank. Xenon lamps for working lights. Automatic lubrication system. Hydraulic power tunnels. Truck hitch. For additional optional equipment, contact your VÖGELE representative.

Key: **V** = equipped with Vibration **VR** = Screed with Rear-Mounted Extensions

*Optional bolt-on support recommended beyond 22 ft.
Specifications subject to change without notice.

4.2.8 CAT AP1000F

Allowable scenarios for 2-lane mainline alignment

PCC Compressive Strength, psi	Offset, inches						
	0	12	24	36	48	60	72
3500			Yes	Yes	Yes	Yes	Yes
4000			Yes	Yes	Yes	Yes	Yes
5000		Yes	Yes	Yes	Yes	Yes	Yes
6000		Yes	Yes	Yes	Yes	Yes	Yes

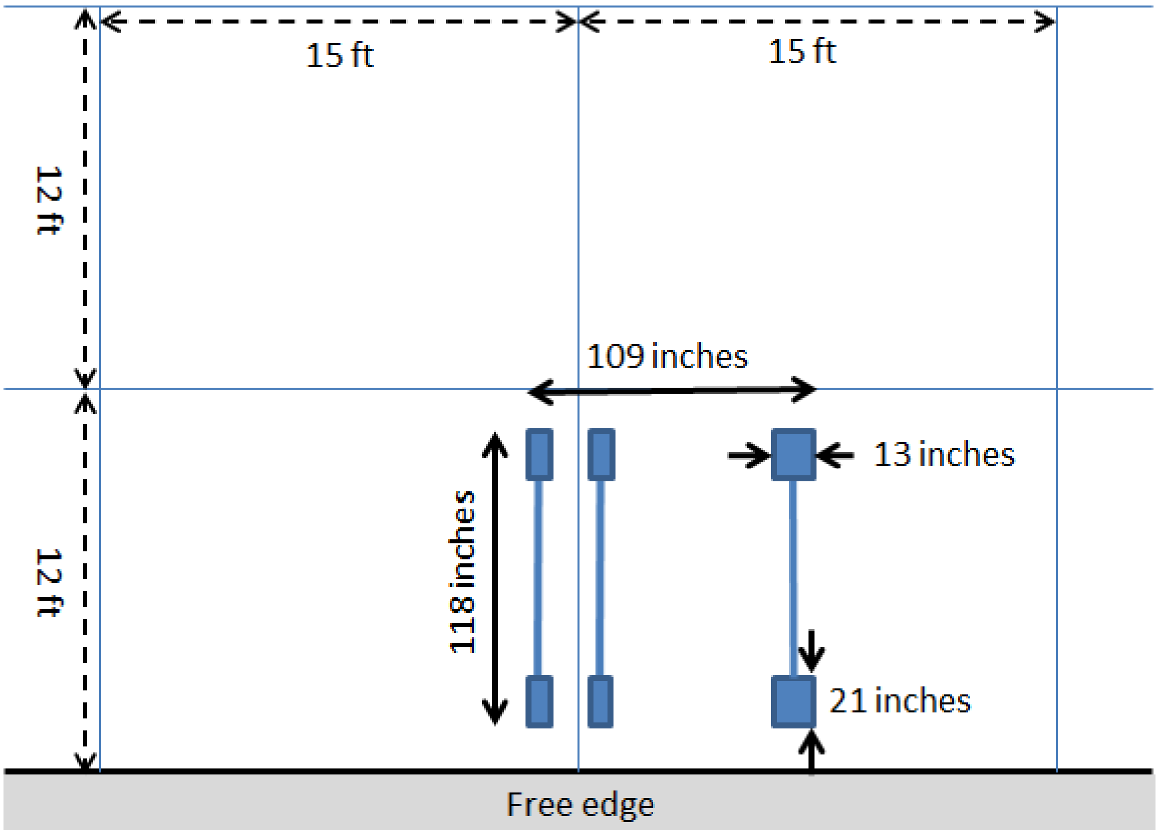
Allowable scenarios for 16-ft ramp alignment

PCC Compressive Strength, psi	Offset, inches			
	0	12	24	36
3500				Yes
4000			Yes	Yes
5000			Yes	Yes
6000		Yes	Yes	Yes

Allowable scenarios for 1-lane, 12-ft mainline

PCC Compressive Strength, psi	Offset, inches	
	0	12
3500		
4000		
5000		Yes
6000		Yes

Footprint for AP1000F (87,000 lb total - 45,500 lb/drive axle; 41,500 lb/hopper)



Specifications:

Engine – Powertrain

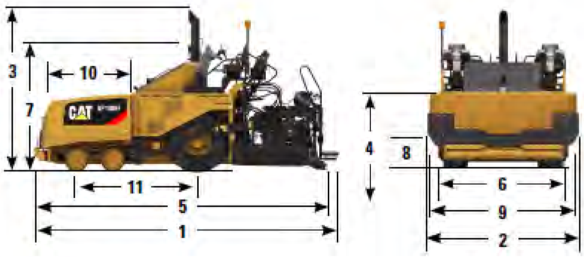
Cat C7.1 ACERT™ Engine		
Australia, U.S., and Canada*	168 kW	225 hp
* Engine meets U.S. EPA Tier 4 Final/E.U.Stage IV emission standards.		
Number of cylinders	6	
Engine speed - maximum/minimum	2200/1100 rpm	
Eco-mode	1650 rpm	
Screed heating - standard width (Quiet)	1300 rpm	
Screed heating - w/extensions (Quick)	1300 to 2200 rpm	
Speed ranges:		
Paving	76 mpm	250 fpm
With Tamper-bar screed	25 mpm	82 fpm
Travel	19.9 km/hr	12 mph

Weights – Australia, U.S., and Canada

AP1000F (tractor only - shipping)	15 526 kg	34,228 lb
AP1000F (tractor only - operating)	15 794 kg	34,820 lb
AP1000F with SE60 V screed	19 044 kg	41,985 lb
AP1000F with SE60 V XW screed	19 719 kg	43,472 lb
AP1000F with SE60 VT XW screed	20 602 kg	45,419 lb

Operating weights include full fuel tank and 75 kg (165 lb) operator.

AP1000F Specifications



Dimensions:

1	Operating length with SE60 V screed	6860 mm	22' 6"
	Operating length with SE60 V XW, VT XW	7050 mm	23' 2"
	Length without screed and canopy	5563 mm	18' 3"
2	Operating width - standard entry hopper	3350 mm	11' 0"
	Operating width - low entry hopper	3600 mm	11' 10"
3	Operating height with canopy, (top of beacon)	4000 mm	13' 1"
	Operating height without canopy	3715 mm	12' 2"
4	Operating deck height	1791 mm	5' 11"
5	Transport length with SE60 V	6720 mm	22' 1"
	Transport length with SE60 V XW, VT XW	6910 mm	22' 8"
6	Transport width with endgates	3211 mm	10' 6"
	Transport width - endgates folded	3000 mm	9' 10"
7	Transport height - canopy retracted	3100 mm	10' 2"
	Transport height - without canopy	3000 mm	9' 10"
8	Truck entry height with standard entry hopper		
	Manual apron	572 mm	22" 5"
	Hydraulic apron	616 mm	24"
	Truck entry height with low entry hopper		
	Manual apron	529 mm	21"
	Hydraulic apron	587 mm	23"
9	Truck entry width - standard entry hopper	3224 mm	10' 7"
	Truck entry width - low entry hopper	3490 mm	11' 6"
10	Hopper length, with pushroller - minimum	2414 mm	7' 11"
11	Wheel base	2776 mm	9' 1"

Screed Specifications

Standard paving range	3.0 - 5.95 m	10' - 19' 6"
Maximum paving width with extensions	7.65 m	25'
Maximum paving depth	305 mm	12"
Crown range - SE60 V, V XW*	-3% to +10%	
SE60 VT XW**	-1.5% to 5%	
Extender height range	-20 mm to + 50 mm	
Extender slope range	-3% to +10%	

* Scale indicator represents total crown for the screed.
** Scale indicator represents crown for each side of the screed.
Note: Total crown capability is the same for both vibratory and tamper bar screeds.

Electrical System

Starting and Charging	24-volt
Alternator	115 amp
Batteries	Two, 1400 CCA
Generator	70 kW
Auxiliary power capability	6.6 kW
Machine Security System	Wire-ready
Product Link System	Wire-ready
Remote jump-start	Yes
Cat Grade and Slope	Integrated

Capacities

Maximum throughput capacity	1602 tonnes/h	1,766 tph
Hopper capacity with tunnels		
Standard entry hopper	7.6 m^3	267 ft^3
Low entry hopper	8.1 m^3	286 ft^3
Fuel tank	348 L	92 gal
DEF (Urea) capacity	19.1 L	5 gal
Cooling system	45.4 L	12 gal
Engine oil	16 L	4.2 gal
Hydraulic tank	219 L	58 gal

Optional Equipment

- Air-ride Seat w/Heat
- Auger and Mainframe Extensions
- Auxiliary Power Panel
- Ballast (front bumper)
- Cat Grade Control
- Decelerator Pedals
- Ecological Washdown System
- Feeder Sensor (mechanical or sonic)
- Front Wheel Assist or All-Wheel Drive
- Hard Top Canopy
- HID Lights
- Leveling Devices
- Lights (Working or Roading)
- Oscillating Push Roller
- Power Folding Front Apron
- Power Mainframe Extensions
- Product Link
- Tow-point Indicators (Upper)
- Truck Hitch
- Umbrella
- Up-time Kit
- Warning Beacon
- Wide Width Paving Packages
- Windshield w/hard top canopy