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# Full-Depth Repair of Portland Cement Concrete Pavements



# Full-Depth Repair of Portland Cement Concrete Pavements Checklist

This checklist is one in a series created to guide State and local highway preservation/maintenance and inspection staff on the use of innovative pavement preservation techniques.

FHWA uses its partnerships with different pavement preservation organizations including American Association of State Highway and Transportation Officials, and State and local transportation agencies to promote pavement preservation.

To obtain other checklists or to find out more about pavement preservation, contact your local FHWA division office or check the following FHWA Web page:

[www.fhwa.dot.gov/pavement/preservation/resources.cfm](http://www.fhwa.dot.gov/pavement/preservation/resources.cfm)

Other valuable resources on pavement preservation:

- [www.acpa.org](http://www.acpa.org)
- [www.cement.org](http://www.cement.org)
- [www.cptechcenter.org](http://www.cptechcenter.org)
- [www.igga.net](http://www.igga.net)

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# Preliminary Responsibilities

## Document Review

- Bid/project specifications and design
- Special provisions
- Traffic control plan
- Manufacturer's installation instructions for the selected repair material(s)
- Material safety data sheets
- Applicable Occupational Safety and Health Administration (OSHA) safety requirements
- See resources

## Project Review

- Verify that pavement conditions have not significantly changed since the project was designed and that full-depth repair is appropriate for the pavement.
- Check estimated number of full-depth repairs against the number specified in the contract.
- Agree on quantities to be placed but allow flexibility if additional deterioration is found below the surface.

## Materials Checks

- Verify that concrete repair material is being produced by a supplier listed on the agency's Approved/Qualified Supplier List as required by contract documents.
- Verify that the mix design for the material being supplied has been sampled and tested prior to installation and conformance to requirements.
- If used, verify the development of maturity curves for the specific mixture for determining opening times.
- Verify that repair material is sampled and tested prior to installation and is not contaminated.
- Verify that load transfer units (dowels) meet specifications and that dowels are properly coated with epoxy (or other approved material) and free of any minor surface damage in accordance with contract documents.
- Verify that dowel-hole cementing grout meets specifications.
- Verify that bond-breaking board meets specifications (typically asphalt-impregnated fiberboard).
- Verify that joint sealant material meets specifications.
- Verify that sufficient quantities of materials are on-hand for completion of the project.

- Ensure that all material certifications required by contract documents have been provided to the agency prior to construction.

## **Equipment Inspections**

### **Concrete Removal Equipment**

- Verify that concrete saws and blades are in good condition and of sufficient diameter and horsepower to adequately cut the required patch boundaries.
- Verify that required equipment used for concrete removal is all on-site and in proper working order and of sufficient size, weight, and horsepower to accomplish the removal process (including front-end loader, crane, fork lift, backhoe, skid steer, and jackhammers).

### **Repair Area Cleaning Equipment**

- Verify that the plate compactor is working properly and capable of compacting subbase material.
- Verify that gang drills are calibrated, aligned, and sufficiently heavy and powerful enough to drill multiple holes for dowel bars.
- Verify that air compressors have oil and are equipped with and use properly functioning moisture filters/traps. Prior to use, check the airstream for water and/or oil by passing the stream over a board, then examining the board for contaminants.

### **Testing Equipment**

- Verify that concrete testing technician(s) meet contract requirements for training/certification.
- Ensure required material test equipment is available on-site and in proper working condition (typically including slump cone, pressure type air meter, cylinder molds and lids, rod, mallet, ruler, and 10 ft straightedge).
- Ensure that sufficient storage area on the project site is specifically designated for the storage of concrete cylinders.

### **Placing and Finishing Equipment**

- Verify that handheld concrete vibrators are the proper diameter and operating correctly.
- Verify that floats and screeds are straight, free of defects, and capable of producing the desired finish.
- Verify that sufficient polyethylene sheeting is readily available on-site for immediate deployment as rain protection of freshly placed concrete, should it be required.

## Weather Requirements

- Verify that air and surface temperatures meet contract document requirements (typically a minimum of 40°F and rising) for concrete placement.
- Repair work should not proceed if rain is imminent. Repairs that have been completed should be covered with polyethylene sheeting to prevent rain damage.

## Traffic Control

- Verify that traffic control conforms to plans and specifications and complies with the *Manual on Uniform Traffic Control Devices* (MUTCD).
- Verify that traffic control personnel are trained/qualified in accordance with contract documents and agency requirements.
- Ensure that the pavement is not opened to traffic until the repair meets minimum strength requirements.
- Ensure that signs are removed or covered when no longer needed.
- Verify that any unsafe conditions are reported to a supervisor (contractor or agency).

## Project Inspection Responsibilities

### Concrete Removal and Cleanup

- Verify removal boundaries are clearly marked and the cumulative removal area is consistent with contract quantities.
- Verify repair is large enough to accommodate a gang-mounted drilling rig, if one is being used. Note: The minimum longitudinal repair length is usually 6 ft.
- Verify that boundaries are sawed vertically the full thickness of the pavement.
- Verify that concrete is removed using either the break-up or lift-out method and minimizing disturbance to the base or subbase as much as possible. Note: The sawcut-and-lift method is preferred to jackhammer removal.
- Verify that any disturbed base or subbase is recompacted, including any added material.
- Verify that adjoining concrete is not damaged or undercut by the concrete-removal operation.
- Ensure that removed concrete is disposed of in accordance with contract requirements.

## Repair Preparation

- Verify that dowel holes are drilled perpendicular to the vertical edge of the remaining concrete pavement using a gang-mounted drill rig.
- Verify drill holes are thoroughly cleaned using compressed air.
- Verify that approved cement grout or epoxy is placed in dowel holes, from back to front.
- Verify that dowels are inserted with a twisting motion, spreading the grout along the bar inside the hole. A grout-retention disk can be used to keep the grout from seeping out of the hole.
- Verify that dowels are installed in transverse joints to the proper depth of insertion and at the proper orientation (parallel to the centerline and perpendicular to the vertical face of the sawcut). Typical tolerances measured perpendicularly to the sawed face are  $\frac{1}{4}$  in. misalignment per 12 in. of dowel bar length.
- Verify that tie bars are installed at the proper location, to the proper depth of insertion, and to the proper orientation in accordance with contract documents. When the length of the longitudinal joint is 15 ft or greater, tie bars are typically installed in the manner used for dowels. When the length of the longitudinal joint is less than 15 ft, a bond-breaker board is placed along the length of the patch to isolate it from the adjacent slab.

- Ensure that tie bars are checked for location, depth of insertion, and orientation (perpendicular to centerline and parallel to slab surface).

## **Placing, Finishing, and Curing Concrete**

- Concrete is typically placed from ready-mix trucks or mobile mixing vehicles.
- Verify that the fresh concrete is properly consolidated using several vertical penetrations of the concrete surface with a handheld concrete vibrator.
- Verify that the surface of the concrete patch is level with the adjacent slab using a straightedge or vibratory screed.
- Verify that the surface of the fresh concrete patch is finished and textured to match adjacent surfaces.
- Verify that adequate curing compound is applied to the surface of the fresh concrete immediately following finishing and texturing. Note: Best practice suggests that two applications of curing compound be applied to the finished and textured surface, one perpendicular to the other.
- Ensure that insulation blankets are used when ambient temperatures are expected to fall below 40°F. Maintain blanket cover until concrete attains the required strength.

## Resealing Joints and Cracks

- Verify that the compressible inserts are sawed out to the dimensions specified in the contract documents when the repair material has attained sufficient strength to support concrete saws.
- Verify that joints are cleaned and resealed according to contract documents.

## Cleanup Responsibilities

- Verify that repairs have attained adequate strength to support concrete saws, and repair perimeters and other unsealed joints are sawed off to specified joint reservoir dimensions.
- Verify that joints are cleaned and resealed.

## Common Problems and Solutions

### (Problem: Solution)

#### **Undercut Spalling (Deterioration on Bottom of Slab) Is Evident after Removal of Concrete from Repair Area:**

- Saw back into adjacent slab until sound concrete is encountered.
- Make double saw cuts, 6 in. apart, around patch area to reduce damage to adjacent slabs during concrete removal.

- Use a carbide-tipped wheel saw to make pressure-relief cuts 4 in. wide inside the area to be removed.

### **Saw Binds When Cutting Full-Depth Exterior Cuts:**

- Shut down saw and remove blade from saw.
- Wait for slab to cool, then release blade if possible, or make another full-depth angled cut inside the area to be removed to provide a small pie-shaped piece adjacent to the stuck saw blade.
- Make transverse saw cuts when the pavement is cool.
- Use a carbide-tipped wheel saw to make pressure-relief cuts 4 in. wide inside the area to be removed.

### **Lifting Out Repair Damages Adjacent Slab:**

- Adjust lifting cables and reposition lifting device to assure a vertical pull.
- Resaw and remove broken section of adjacent slab.
- Ensure the lifting device is capable of performing the operation.

## **Slab Disintegrates When Attempts Are Made to Lift it Out:**

- Complete removal of repair area with backhoe or manual labor.
- Angle lift pins and position cables so that fragmented pieces are bound together during lift-out.
- Keep lift height to an absolute minimum on fragmented slabs.

## **Repairs Become Filled with Rainwater or Groundwater Seepage, Saturating the Subbase:**

- Pump the water from the repair area or drain it through a trench cut into the shoulder.
- Recompact subbase to a density consistent with contract documents, adding material as necessary.
- Allow small depressions in subbase to be filled with aggregate dust or fine sand before repair material is placed. Permit the use of aggregate dust or fine sand to level small surface irregularities (1/2 in. or less) in surface of subbase before concrete repair is placed.

### **Grout Around Dowel Bars Flows Back Out of the Holes after Dowels Are Inserted:**

- Place grout or epoxy to the back of the hole first.
- Use a twisting motion when inserting the dowel.
- Add a grout retention disk around the bar to prevent grout from leaking out.

### **Dowels Appear to Be Misaligned Once They Are Inserted Into Holes:**

- If misalignment is less than  $\frac{1}{4}$  in. per 12 in. of dowel bar length, do nothing.
- If misalignment is greater than  $\frac{1}{4}$  in. per 12 in. of dowel bar length on more than three bars, resaw patch boundaries beyond dowels and redrill holes.
- Use a gang-mounted drill rig referenced off the slab surface to drill dowel holes.

# Common Performance Problems and Prevention Techniques

## **(Problem: Solution)**

### **Longitudinal Cracking in Repair:**

- Verify repair dimensions, not too short.
- Verify proper isolation material and technique has been used.
- Verify proper curing material and application.
- Determine if extreme environmental conditions occurred during placement.

### **Transverse Cracking in Repair:**

- Verify repair dimensions, not too long.
- Verify joints are active and not locked and proper dowel size and location.
- Verify proper curing material and application.

### **Surface Scaling:**

- Investigate mix design adequacy.
- Investigate excess water application during placement or finishing.
- Investigate over finishing surface.
- Verify proper curing material and application.

### **Spalling of Transverse or Longitudinal Joint:**

- Verify steel placement is correct and that transverse joints are not locked.
- Verify no incompressibles in joints.
- Verify no point load conditions have occurred in repair area.

### **Deterioration of Material Surrounding Repair:**

- Investigate inadequate boundary marking or removal techniques used.
- Investigate whether full-depth saw techniques were used.

### **Repair Settlement:**

- Investigate base preparation technique used.
- Investigate presence of excess moisture.
- Investigate effectiveness of load transfer devices.

## **Web-Based Training**

- NHI-134207A How to Construct Durable Full-Depth Repairs in Concrete Pavements

## Sources

Information in this checklist is based on or refers to the following sources:

*Concrete Pavement Preservation Guide, Second Edition*. Pub. No. FHWA-HIF-14-004. 2014. Ames, IA: Iowa State University, National Concrete Pavement Technology Center. Available at [https://intrans.iastate.edu/app/uploads/2018/08/preservation\\_guide\\_2nd\\_ed\\_508\\_final.pdf](https://intrans.iastate.edu/app/uploads/2018/08/preservation_guide_2nd_ed_508_final.pdf).

Darter, M. 2017. *Concrete Repair Best Practices: A Series of Case Studies / Full Depth Repair Tech Brief*. Missouri Department of Transportation, Jefferson City, MO.

*Guidelines for Full-Depth Repair, Concrete Paving Technology*. Pub. No. TB002P. 1995. Skokie, IL: American Concrete Pavement Association. Available at [www.pavement.com](http://www.pavement.com).

*How to Construct Durable Full-Depth Repairs in Concrete Pavements, Web Based Training (WBT)*. NHI-134207A. Washington, DC: Federal Highway Administration, National Highway Institute.

*Manual on Uniform Traffic Control Devices*. 2009, Revised May 2012. Washington, DC: Federal Highway Administration. Available at <http://mutcd.fhwa.dot.gov>.

**For more information on the Pavement Preservation Checklist Series, contact:**

Construction Management Team, HICP-30  
Office of Preconstruction, Construction,  
and Pavements

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July 2019

Publication No. FHWA-HIF-19-049

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U.S. Department of Transportation  
**Federal Highway Administration**