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# Dowel-Bar Retrofit for Portland Cement Concrete Pavements



# Dowel-Bar Retrofit for 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
- Agency application requirements
- Traffic control plan
- Manufacturer's installation instructions
- Material safety data sheets

## Project Review

- Verify that pavement conditions have not significantly changed since the project was designed.
- Check estimated quantities for dowel-bar retrofit (DBR).

## Materials Checks

- Verify that dowel slot patching material meets specification requirements.
- Verify that dowel slot patching material is being obtained from an approved source or listed on the agency Qualified Products List, as required by the specification.
- Verify that the patching material components for the dowel slot have been sampled, tested, and approved prior to installation as required by contract documents.
- Verify that additional or extender aggregates have been properly produced, with acceptable quality.
- If a mix design is required, ensure it has been approved and includes all the materials/additives to be incorporated into the mix.
- Verify that material packaging is not damaged, (e.g., packages leaking, torn, or pierced), preventing proper use.
- Verify that caulking meets specification requirements.
- Verify that dowels, dowel-bar chairs, and endcaps meet specification requirements.
- Verify that dowel bars are properly coated with epoxy (or other approved material) and free of any minor surface damage in accordance with contract documents.
- Verify that curing compound meets specification requirements.

- Verify that joint/crack re-former material (compressible insert) meets specification requirements (typically polystyrene foam board, ½ in. thick).
- Verify that joint sealant material meets specification requirements.
- Verify that all required materials are on hand in sufficient quantities to complete the project.
- Ensure that all material certifications required by contract documents have been provided to the agency prior to construction.

## **Equipment Inspections**

### **Slot Cutting and Concrete Removal Equipment**

- Verify that slot-sawing machine is of sufficient weight, horsepower, and configuration to cut the specified number of slots per wheel path to the depth and locations shown on the plans.
- Verify that vacuum equipment used in conjunction with gang-sawing operations to remove slurry is functioning properly.
- Verify that removal jackhammers are limited to a maximum rated weight of 30 lb.
- Verify that tools such as bush hammers are available if needed to produce a flat, level bottom.

## Slot Cleaning and Preparation

- Abrasive cleaning unit is adjusted for correct abrasive feed rate and has properly functioning oil and moisture trap.
- Verify the airstream contains no water or oil prior to use by passing the stream over a board and examining for contaminants.
- Abrasive cleaning uses environmentally acceptable abrasive media.
- Abrasive cleaning operators use appropriate air purification systems as required. (Occupational Safety and Health Administration [OSHA] requirements and equipment types are in use and functioning properly.)
- Verify that air compressors have sufficient pressure and volume to adequately remove all dust and debris from slots and meet agency requirements.

## Mixing and Testing Equipment

- For auger-type mixing equipment, ensure that auger flights or paddles are kept free of material buildup, which can cause inefficient mixing operations.
- Ensure that volumetric mixing equipment, such as mobile mixer, is kept in good condition and is calibrated on a regular basis to properly proportion mixes.



- Ensure that material test equipment required by the specifications are all available on site and in proper working condition (typically including slump cone, pressure-type air meter, cylinder molds and lids, rod, mallet, and ruler).

### **Other Equipment**

- Verify that vibrators are the size specified in the contract documents (typically 1 in. in diameter or less) and are operating correctly.
- Verify that the concrete testing technician meets the requirements of the contract document for training/certification.
- Ensure that sufficient storage area is available on the project site specifically designated for the storage of concrete cylinders.

### **Weather Requirements**

- Review manufacturer installation instructions for requirements specific to the dowel slot patching material.
- Air and surface temperature meet agency requirements (typically 40°F and rising) for patching material placement.
- Neither dowel bar installation nor patching should proceed if rain is imminent.

## Traffic Control

- Verify that signs and devices conform to the traffic control plan presented in the contract documents.
- Verify that the setup complies with the *Manual on Uniform Traffic Control Devices* (MUTCD).
- Verify that flaggers are trained/qualified according to contract documents and agency requirements.
- Verify that unsafe conditions, if any, are reported to a supervisor.
- Ensure that if slot sawing is allowed to proceed faster than concrete removal and dowel installation, traffic is not allowed to drive on the saw cuts for a period greater than specified in the contract (typically five days).
- Verify that temporary dowel slot patching material is available should the backfilling operation break down (asphalt concrete [AC] is typically used).
- Ensure that traffic is not opened to the repaired pavement until the dowel slot patching material has attained the specified strength or curing time as required by the contract documents.
- Verify that signs are removed or covered when they are no longer needed.

# Project Inspection Responsibilities

## Slot Cutting and Removal

- ❑ Verify that all slots are cut parallel to each other and to the centerline of the roadway within the maximum tolerance permitted by the contract documents, typically  $\frac{1}{4}$  in. per 12 in. of dowel bar length.
- ❑ For projects with skewed joints, ensure the dowels are installed parallel to the centerline and not perpendicular to the joint.
- ❑ Verify that the number of slots per wheel path (typically three or four) agrees with contract documents.
- ❑ Verify that the cut slot length extends the proper distance on each side of the joint as required by the contract documents.
- ❑ Verify that concrete between the saw cuts is removed using 30 lb maximum weight jackhammers and/or with prying or breaking bars.
- ❑ Verify that the bottoms of slots are smoothed and leveled using lightweight bush hammer.

## Slot Cleaning and Preparation

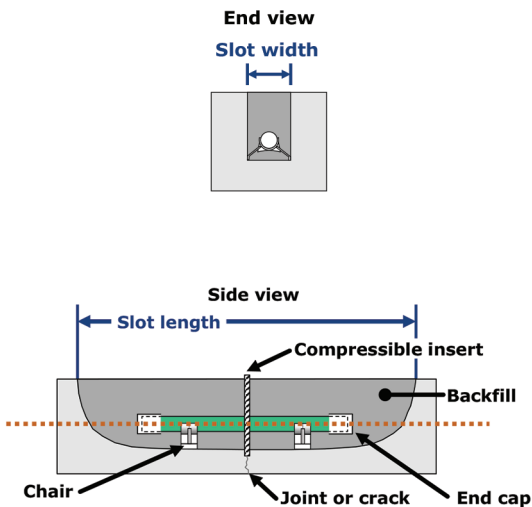
- Verify that after concrete removal, slots are prepared by media blasting, ensuring that all saw slurry is removed from the slot. (It is good practice to clean 3–4 ft away from the slot's perimeter.)
- Verify that air blasting is utilized to clean slots. A second air blasting may be required immediately before placement of dowel slot patching material if slots are left open and become dirty.
- Verify that the existing joint/crack is sealed with approved caulking along the bottom and sides of slot to prevent concrete patch material from entering the joint/crack. Ensure sealant does not extend more than ½ in. away from joint.

## Placement of Dowels

- Verify that plastic endcaps are placed on each end of the dowel bar to account for pavement expansion (see Figure 1) as required by the contract documents.
- Verify that dowels have been coated with an approved bond release compound to prevent bonding of dowel slot patch material to dowels.
- Verify that proper clearance is maintained between the supported dowel bar and the sidewalls, ends, and bottom of the cut slot in accordance with contract documents.

Schematic diagrams presented in Figure 1 are intended for reference purposes only and are not intended to supersede contract documents.

- Verify that chairs are used to align the dowel correctly in the slot and support it, and permit dowel slot patching material to completely encapsulate the dowel bar (typically  $\frac{1}{2}$  in. clearance between the bottom of the dowel and the bottom of the slot).



*Figure 1. Dowel-bar retrofit schematic*

- Verify that joint re-former material (foam core insert) is placed at the mid-point of each bar and in line with the joint/crack to allow for expansion and to re-form the joint/crack.
- Verify that dowels are centered across the joint/crack such that at least 6 in. of the dowel extends on each side in accordance with contract documents.

### **Mixing, Placing, Finishing, and Curing Patching Material**

- Verify whether test strips are required in the contract, and if so, that they are conducted and accepted prior to full scale production. (Typically, 20 joints/cracks are used for a test section length.)
- Verify that dowel slot patching materials are mixed in accordance with manufacturer recommendations, and in small enough quantities to prevent premature set.
- Verify that concrete surfaces, including the bottom of the slots, are dry before placement of patching materials.
- Verify that material is consolidated using small, hand-held vibrators that do not touch the dowel bar assembly during consolidation.

- Verify that concrete patch material is finished flush with surrounding concrete, using an outward motion to prevent pulling material away from patch boundaries. The surface of the concrete patch material should be finished slightly “humped” if diamond grinding will be done.
- Verify that transverse joint is re-established in patching material within 24 hours of placement.
- Verify that adequate curing compound is applied immediately following finishing and texturing in accordance with contract documents.
- Verify that the DBR operation is proceeding satisfactorily by retrieving cores, if required by the contract, to ensure proper dowel positioning and consolidation of the patching material. (Typically, 1 core is retrieved every 600 bars or a day’s production, whichever is less.)

## **Cleanup Responsibilities**

- Verify that all concrete pieces and loose debris are removed from the pavement surface and disposed of in accordance with contract documents.
- Verify that mixing, placement, and finishing equipment is properly cleaned for the next use.

## Diamond Grinding

- Diamond grinding, if required, should be conducted after completion of the repair work and prior to installation of joint sealant (except for patch repair areas).

## Resealing Joints and Cracks

- Verify that joints are resealed after diamond grinding in accordance with contract documents.

## Common Problems and Solutions

### **(Problem: Solution)**

#### **Sawcuts (Sides of Slots) Are Not Parallel to Each Other or the Pavement Centerline:**

- Cease work immediately.
- Use a saw slot cutting machine.

#### **Slots Are Cut Too Shallow:**

- Resaw the slots and remove concrete to the proper depth.



### **Slots Are Cut Too Deep:**

- Use a lighter weight jackhammer, maximum 30 lb.
- Do not lean on the jackhammer.
- Do not orient the jackhammer vertically; use less than a 45° angle and push the tip of the hammer along the bottom of the slot.
- Stop chipping when within 2 in. of the bottom of the pavement.
- If jackhammers punch through the bottom of the slot, consider repairing an individual slot, by replacing the broken material at the bottom with patching material to provide a good platform for the dowel assembly. If several slots are broken through, a full depth repair across the entire lane width may be necessary.

### **Concrete Slot Is Not Easily Removed:**

- Check for mesh reinforcement, and sever the steel at each end before attempting to remove the fin of concrete.

### **Coating On Dowel Is Damaged:**

- Repair using manufacturer's approved coating.

### **Dowel Cannot Be Centered Over Joint/Crack Because Slot Does Not Extend Far Enough:**

- Chip out additional slot length with a jackhammer to facilitate proper placement of steel dowel in accordance with contract documents. Typically, at least 6 in. of each 14 in. dowel extends on each side of joints. Properly sized chairs will fit snugly into the slot.

### **Caulking Does Not Extend All The Way to the Edge of the Slot:**

- Repair before proceeding.

### **Dowels Are Misaligned after Vibration:**

- Do not allow the vibrator to touch the dowel assembly.
- Check for over-vibration; each slot should require only two to four short, vertical penetrations of a small-diameter spud vibrator.
- Ensure that the slots are sized the exact width of the plastic dowel-bar chairs.

### **Cracking of In-Place Patching Material:**

- Joint not well isolated.
- Dowels not properly aligned.
- Improper backfill/consolidation procedures.
- Improper curing.

## Abrasion of Patching Material Surface:

- Improper material, mixing, consolidation, and/or curing.

## Web-Based Training

- NHI-134207D Proper Construction Techniques for Dowel Bar Retrofit and Cross-Stitching

## 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).

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

Pierce, L. M., Uhlmeier, J. S., and Weston, J. 2009. *Dowel Bar Retrofit —Do's and Don'ts*. WA-RD 576.2. Washington State Department of Transportation, Olympia, WA.

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Snyder, M. B. 2011. *Guide to Dowel Load Transfer Systems for Jointed Concrete Roadway Pavements*. Institute for Transportation, Iowa State University, Ames, IA. Available at <https://intrans.iastate.edu/app/uploads/2018/08/Dowel-load-guide.pdf>.

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

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