CONCRETE PAVEMENT GUIDE

PART 3: PRESERVATION STRATEGIES

CHAPTER 330 – DOWEL BAR RETROFIT

330.1 PURPOSE AND DESCRIPTION

Dowel bar retrofit (DBR) is applied to JPCP originally constructed without dowels at transverse joints. DBR is a CAPM preservation strategy that can significantly prolong pavement service life from 10 to 15 years by improving load transfer efficiency (LTE) across joints and cracks. Dowel bars significantly decrease relative movement across joints and cracks under load, thus reducing faulting development and further deterioration of joints and cracks. DBR is combined with diamond grinding to provide a smooth-riding pavement surface.

The DBR process entails cutting parallel slots across the existing transverse joints and cracks, installing dowel bars in these slots, and backfilling the slots with polyester concrete (see Figure 330-1).

Figure 330-1: Completed dowel bar retrofit (single wheel path shown)

DBR to restores load transfer efficiency at JPCP joints or cracks. By restoring load transfer, the stresses in the slab and deflections at the joint can be reduced, extending the anticipated pavement service life.

330.2 DBR COMPONENTS

The DBR process contains the following components:

- Dowel bar slots cut into the existing concrete
- Caulk
- Dowel bars
- End caps
- Dowel support chairs
- Foam insert
- Polyester concrete backfill

A brief discussion of each of these components is presented below.

330.2.1 Dowel Bar Slots

Slots are cut in the concrete surface in order to place dowel bars into the existing pavement. The slots are 2.5" wide and parallel to each other and the longitudinal pavement joint. The slots are cut deep enough to allow space below the installed dowel bar for the backfill concrete to completely encase the bar.

330.2.2 Caulk

Latex caulk is used to prevent backfill concrete from entering the existing joint and crack. The caulk is placed into the joint and crack at the sides and bottom of the dowel bar slot. If the polyester concrete backfill material enters the space between adjacent pavement slabs, free movement at the joint could be inhibited, leading to joint damage.

330.2.3 Dowel Bars

Dowel bars are typically solid, smooth steel bars. The bars will either be epoxy coated or made of corrosion resistant steel and are coated with lubricant or release agent to allow longitudinal movement in the concrete backfill. The longitudinal movement allowance permits normal JPCP slab volume change with temperature cycling (see Section 120.1.1). In some special cases fiberglass bars may be used, but they are currently experimental and should only be used by nSSP under the direction of the Headquarters Division of Maintenance Pavement Program. Figure 330-2 shows the epoxy coated steel bars with end cap, support chair, and foam insert.

Figure 330-2: Dowels with end caps, support chairs, and foam inserts

330.2.4 End Caps

Using end caps on the dowel bars establishes a small gap between the dowel bar and the polyester concrete backfill at each end of the bar. As moisture content and temperature of the pavement changes, the concrete volume varies changing the joint width. The gap at the end of the dowel bar accommodates those changes.

330.2.5 Support Chairs

Support chairs hold the dowel bars in position inside the slots as the concrete backfill is placed, consolidated, and sets.

330.2.6 Foam Insert

A foam insert is used to form a joint in the polyester concrete backfill rather than saw cutting because the joint must extend through the entire backfill depth. The existing pavement may be at less than its maximum volume so shrinkage cannot be relied upon to create the joint.

330.2.7 Polyester Concrete Backfill

The polyester concrete backfill must perform the functions of holding the dowel bar in place and transferring load from the concrete pavement to the dowel bar, and from the dowel bar to the concrete pavement on the opposite side of the joint. Load is transferred between the pavement and the backfill through shear forces at the sides of the dowel bar slot. Load is transferred to and from the dowel bar through compressive forces at the top and bottom of the dowel bar.

330.3 PROJECT SELECTION

DBR is a preservation strategy that is suited to pavement that is structurally sound with relatively small amounts of slab cracking and low LTE < 70% at transverse joints and cracks. Generally, DBR can be effective for:

- An aging structurally sound pavement, with adequate thickness, exhibiting poor load transfer due to lack of dowels and poor aggregate interlock.
- A relatively young pavement in good condition but with the potential to develop faulting, working cracks, or corner breaks due to insufficient slab thickness, joint spacing greater than 15 feet (4.6 m), or inadequate joint load transfer.

330.3.1 Appropriate Use

Load Transfer – Perform a LTE survey of each lane in the pavement segment being considered for DBR. The survey should consist of at least 10 joints per ¼-mile. Pavements with LTE values < 70 percent are considered viable candidates for DBR.

3rd stage cracking – Perform a crack survey of the project. Count the slabs that have been replaced and slabs that have 3rd stage cracking. If the number of slabs with 3rd stage cracking plus those that have already been replaced is < 2% per lane in the pavement segment, DBR may be appropriate. If 3rd stage cracking plus replaced slabs is between 2 to 5%, and average accumulated faulting (current faulting plus previously ground faulting) is < 0.6", DBR may be appropriate.

330.3.2 Limitations

Do not perform DBR on pavement with any of the following conditions:

- Extensive 3rd Stage cracking – 3rd stage cracking plus slab replacement exceeding 5 percent is unsuitable for DBR. Pavement with 3rd stage cracking in excess of 5% is approaching the limit of its

functional life; individual lab replacement for the short term and rehabilitation for the long term are more appropriate strategies.

- Concrete integrity – Concrete pavement with materials related distress such as alkali-silica reaction (ASR) or freeze thaw related deterioration is unsuitable for DBR.

- Structural condition of base – The base should be in good structural condition to support the slabs. If the base is exhibiting pumping or non-uniform support conditions, then DBR is not appropriate.

- Joint or crack spalling – DBR treatments require sound material near the transverse joint or crack to ensure adequate transfer of load from one slab to another. Transverse joints and cracks with extensive high-severity spalling > 2 ft^2 are not candidates for DBR.

If localized distress within the pavement segment limits continuous DBR application, consider using a combination of strategies (see Section 100.3.2) with DBR such as spall repair (Ch. 310) and slab replacement (Ch. 320) within the project limits.

330.3.3 Recommended Applications

Most transverse cracks should be retrofit with dowel bars. Figures 330-3 through 330-6 show recommended strategies based on existing slab condition, excluding severity (crack width). Slabs with cracks that are not retrofit should be replaced with longer design life Type I slab replacements (see Ch. 320).

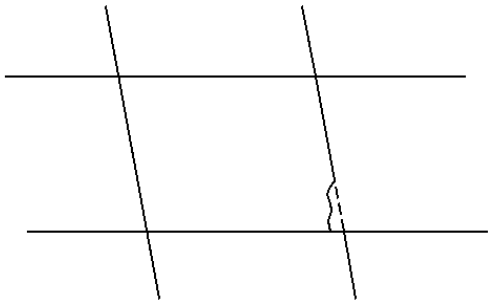
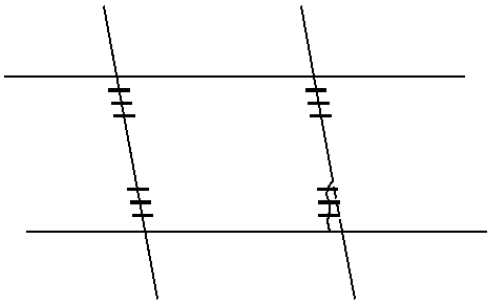
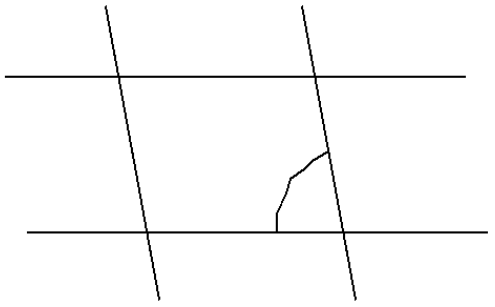
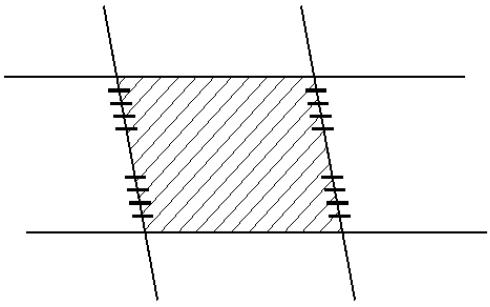
Existing Slab Condition	Appropriate Strategy
 Working corner crack: corner attached to adjacent slab	 DBR crack
 Corner crack: corner is an independent piece	 Replace slab using RSP P8

Figure 330-3: Corner cracking strategies

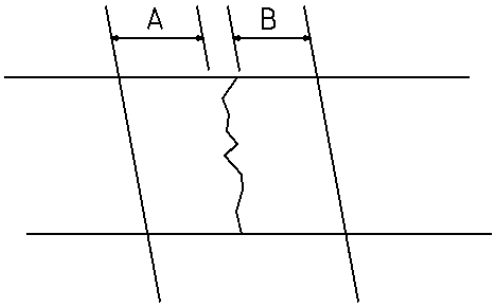
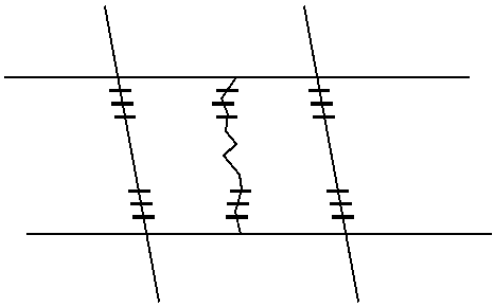
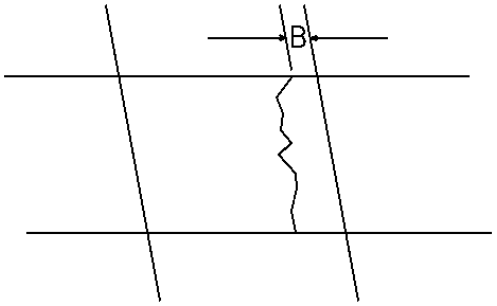
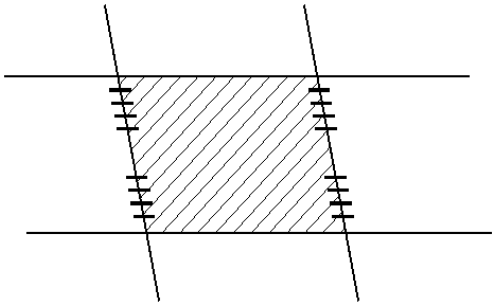
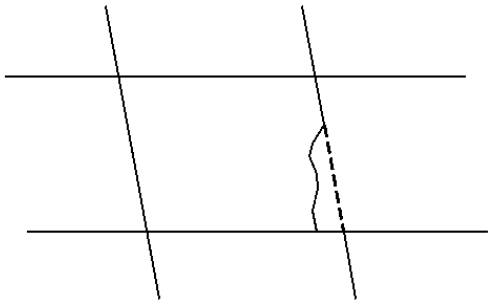
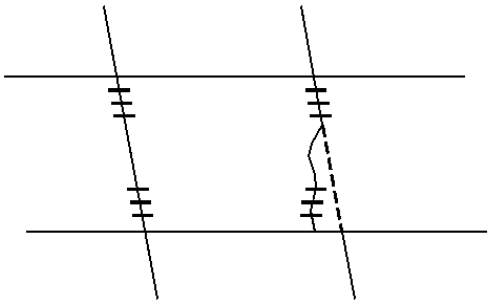
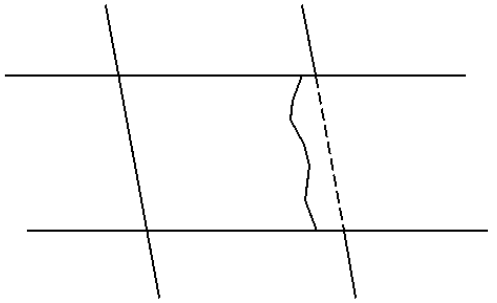
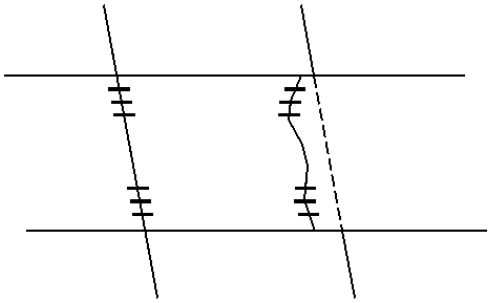
Existing Slab Condition	Appropriate Strategy
 Transverse crack: A and B greater than 3 ft	 DBR crack and joints
 Transverse crack: 'B' less than 3 ft	 Replace slab using RSP P8
 Transverse crack partially formed at saw cut	 DBR joints and active transverse crack
 Saw cut did not crack: transverse crack is active joint	 DBR transverse crack

Figure 330-4: Transverse cracking strategies

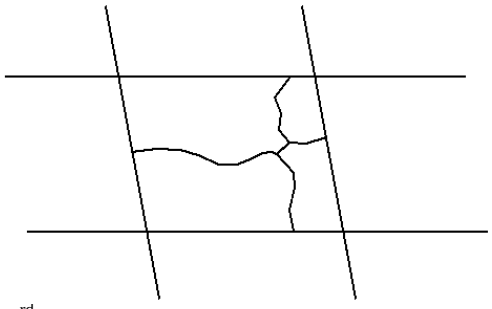
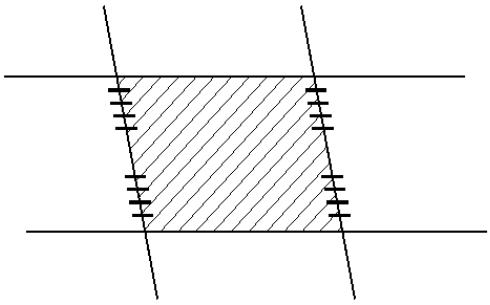
Existing Slab Condition	Appropriate Strategy
	
3rd stage cracking: slab cracked into 3 or more pieces	Replace slab using RSP P8

Figure 330-5: 3rd stage cracking strategy

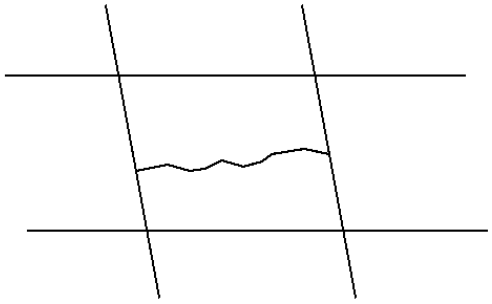
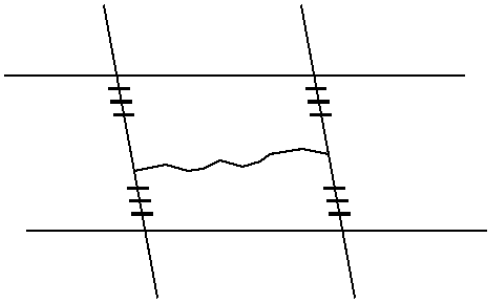
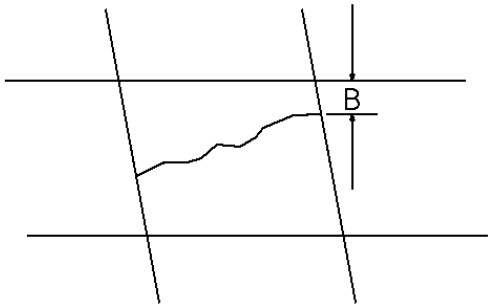
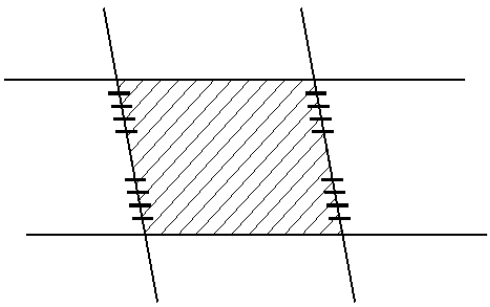
Existing Slab Condition	Appropriate Strategy
	
Longitudinal crack mid panel	DBR joints
	
Longitudinal crack: B less than 4 ft	Replace slab using RSP P8

Figure 330-6: Longitudinal cracking retrofit/replace strategies

330.4 PLANS, SPECIFICATIONS, AND ESTIMATING

330.4.1 Plans

Accurately indicate DBR and grinding limits on the project layout and typical cross section sheets. DBR details are shown on Revised Standard Plan RSP P7, available on the Office Engineer internet site: http://www.dot.ca.gov/hq/esc/oe/project_plans/highway_plans/stdplans_US-customary-units_10/viewable_pdf/rspp07.pdf.

Typically only the truck lanes are retrofitted, however, at locations where a JPCP auxiliary lane is adjacent to a lane being retrofitted, it should also be retrofitted regardless of its condition.

The entire limits of DBR work must be ground for smoothness using a separate pay item under Section 42 of the Standard Specifications.

330.4.2 Specifications

In the 2010 Standard Specifications, Section 41-8 is reserved for dowel bar retrofit using standard special provision (SSP) 41-8, which can be found on the Office Engineer website at http://www.dot.ca.gov/hq/esc/oe/construction_contract_standards/SSPs/2010-SSPs/division_5/41-8_A07-19-13.docx.

330.4.3 Estimating

The quantity sheets should indicate separate quantities for dowel bar retrofit (joint), dowel bar retrofit (crack), and grind existing concrete pavement. The construction effort to retrofit cracks is greater than to retrofit joints, so the cost will be a bit higher. In cases where DBR is performed on a joint that is formed partially along the saw cut and partially along a volunteer path, estimate the work as half DBR (joint) and half DBR (crack). Where a slab needs to be replaced, do not include the transverse joints at each end of or within the replacement area in the retrofit quantities since dowels will be installed as part of the slab replacement.

Dowel bar retrofit is paid for by each joint or each crack. The bid items are listed in Table 330-1:

Table 330-1: Dowel Bar Retrofit 2010 Bid Items

Item Code	Description	Unit	Standard Specification Sections
410091	DOWEL BAR RETROFIT (JOINT)	EA	41-1.01; 41-8
410092	DOWEL BAR RETROFIT (CRACK)	EA	41-1.01; 41-8
420201	GRIND EXISTING CONCRETE PAVEMENT	SQYD	42-3

After retrofitting joints and cracks with dowel bars, the entire surface width of the adjoining slabs must be ground. Grinding is paid separately from dowel bar retrofit, so include Item 420201 Grinding Existing Concrete Pavement in the work item estimate.

Typically, some slabs within the project limits will require replacement using the criteria given in Section 320.2 and in Section 330.3.3. Include item 411105 Individual Slab Replacement (RSC).

If spall repair is also needed within the project limits, it is measured by the square yard. Spall repair with polyester concrete (Item 410120) should be used since the repairs last longer and use polyester concrete materials similar to those used for DBR (see Ch. 310).