DOWEL BAR RETROFIT – DO'S AND DON'TS

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Strategic Planning and Programming
in cooperation with the U.S. Department of Transportation
Federal Highway Administration

Dowel Bar Retrofit – Do's and Don'ts

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16. ABSTRACT

This report documents construction and inspection guidelines for the successful construction of a dowel bar retrofit project.

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General Steps for Dowel Bar Retrofit Construction

1. Cut dowel bar retrofit slots.

2. Remove existing concrete from slots.

3. Clean slots of all debris.

4. Place silicone at all joints/cracks.

5. Place dowel bar assemblies in slots.

6. Place patching material.

7. Consolidate patching material.

8. Finish patching material.

9. Diamond grind pavement surface.

1. Cutting Slots

Saw cut slots should be prepared such that dowel bars (1½ inch diameter and 18 inches in length) can be placed at the mid depth of the concrete slab, centered over the transverse joint, and parallel to the centerline and the roadway surface.

<u>Dowel Bar Placement Tolerances</u>

- ± 1 inch of the middle of the concrete slab depth
- ± 1 inch of being centered over the transverse joint
- ± ½ inch from parallel to the centerline
- ± ½ inch from parallel to the roadway surface

Sawcuts sawed across skewed joints should allow equal length of the dowel bar to be placed across the transverse joint.

Photo 1. Saw cutting slots.

Photo 2. Cut slots, parallel to centerline and perpendicular to transverse (non-skewed) joint.

Photo 3. Dowel bar retrofit slots placed parallel to centerline over a skewed joint.

The alignment of sawcuts must be parallel to the roadway centerline, regardless of transverse joint skew. Dowel bar slots placed perpendicular to skewed joints will cause joint lock up and lead to pavement cracking.

Saw cuts that are sawed too deep will contribute to corner cracks when traffic loads are applied. To determine the depth of saw cutting, the contractor should physically measure the depth by placing a dowel bar in the dowel bar chairs, measure from the middle of the dowel to the bottom of the chairs, and then add one half the pavement depth to determine the proper saw cut depth. This measurement should be done as dowel bar chairs dimensions sometimes vary from what is specified.

Slots should be aligned to miss existing longitudinal cracks. Slots that intersect longitudinal cracks will fail. The failure mechanism is typically the debonding of the concrete patching material from the walls of the saw cut slot. Shifting slots, 3 to 4 inches one way or another, will prevent this problem and will still provide the required load transfer. If a gang saw is used, slots may be sawed but not retrofitted. Non-retrofitted saw cuts should be cleaned and sealed with an epoxy resin.

Photo 4. Slots should not be placed perpendicular to skewed joints.

Photo 5. Corner cracking resulting from traffic loading when sawcuts penetrate too deep in the concrete roadway.

Photo 6. Existing longitudinal crack that intersected a dowel bar retrofit slot.

Photo 7. Align dowel bar slots to miss an existing longitudinal crack.

2. Removing Existing Concrete from Slots

Jackhammers weighing 30 pounds or less should be used to break loose the concrete from the slots.

Jackhammers must not be used vertically to the plane of the concrete pavement. Jackhammers operated in a vertically position often punch through the floor of the slots.

Many contractors have used 15-pound jackhammer to level the bottom of the slot. Leveling the bottom of the slot will help to ensure that the dowel bar will meet alignment tolerances.

Photo 8. Maintain jackhammer at a 45-degree angle.

Photo 9. Leveling the bottom of a slot.

Photo 10 illustrates the improper removal of the concrete from the slot. Assuming that the saw cut was of sufficient depth, concrete material still remains in the slot. This high point will result in a skew of the horizontal position of the dowel bar.

Photo 11 illustrates poor removal of the slot material at the back of the slot, which may result in insufficient clearance between the end of the dowel bar and the back of the slot.

Photo 10. Concrete improperly removed from the bottom of the slot.

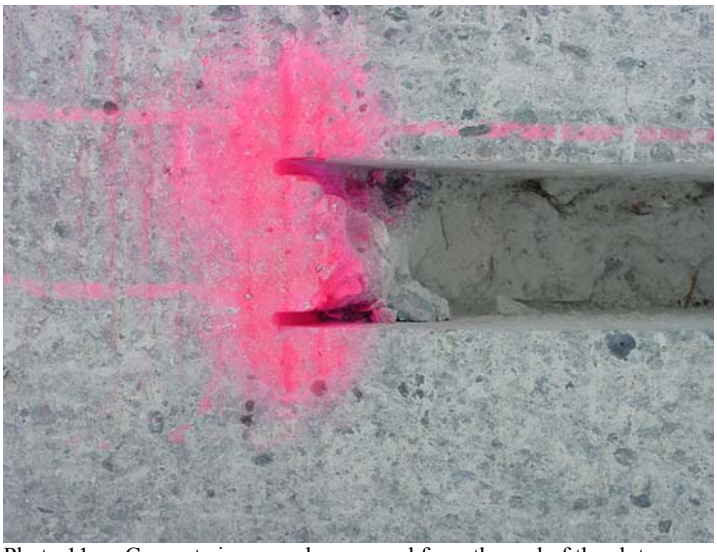


Photo 11. Concrete improperly removed from the end of the slot.

3. Cleaning Slots

All exposed surfaces and cracks in the slot should be sand blasted and cleaned to bare concrete to remove slurry, parting compound, or other foreign materials prior to installation of the dowel.

Compressed air should be used to remove concrete chunks, dirt, debris, water, and slurry from the sides and bottom of the slots.

Removal of dirt and the slurry residue can be a difficult challenge if water is present in the slot. If water is present, slurry residue is redistributed to the bottom or sides of the slots by sandblasting or compressed air. More than one attempt at cleaning the slot may be necessary.

Protection to the public from sand blasting debris should be provided. Often, a plywood sheet placed adjacent to the lane is sufficient. If approved, a high-pressure water blast can be used to clean the slots.

A physical check of the slots cleanliness (using a tool such as a scraper) should be made to ensure no slurry residue remains on the sides of slots.

Concrete chunks, dirt, debris, and slurry residue should be cleaned to a minimum of 4 feet from the slots perimeter. Otherwise, dirt and debris is easily reintroduced to the slot during dowel bar and concrete patching material placement operations.

Photo 12. Cleaning slot.

Photo 13. Provide protection to traffic during the sandblasting operation.

Photo 14. Cleaning slots with compressed air.

Photo 15. Slots and the surrounding concrete area have been cleaned.

Photo 16. Removal of water, from slots, is required prior to placement of patching material.

Photo 17. Sandblasting debris adjacent to slots should be cleared to avoid contamination during placement of patching material.

4. Silicone Sealant in Slots

Prior to placement of the dowel bar and concrete patching material, the transverse joint or crack should be caulked at the bottom and sides of the slot. The caulking filler should not be placed any farther than ½ inch outside either side of the joint or crack. Excessive sealant around the slot does not allow the concrete patching material to bond to the sides of the slot.

The transverse joint or crack should be caulked sufficiently to prevent any of the patching material from entering the joint/crack at the bottom or sides of the slot.

Photo 18. Caulking should be placed along the sides and bottom of the slots.

Photo 19. Slot has been caulked with silicon sealant.

5. Dowel Bar Placement

The epoxy coating on dowel bars should be free of nicks and abrasions prior to use.

Prior to placement, the dowel bars should be lightly coated with a parting compound and placed on a chair that will provide a minimum of ½ inch clearance between the bottom of the dowel and the bottom of the slot. The parting compound should be applied prior to placement of the dowel bar into the slot.

The chair design should hold the dowel bar tightly in place during placement of the concrete patching material.

A ⅜ inch thick foam insert should be placed at the middle of the dowel to maintain the transverse joint. The foam insert should fit tightly around the dowel, the bottom and the edges of the slot, and be a minimum of 1½ inch below the existing concrete surface. The foam insert should be capable of remaining in a vertical position and held tightly to all edges during placement of the patch. If for any reason the foam insert shifts during placement of the concrete patching material, the work should be rejected and redone at the Contractor's expense.

The foam core insert, positioned on the dowel bar, is used to ensure that a joint is formed directly in line with the existing joint and to allow for the expansion of the concrete patching material.

Photo 20. Prepared dowel bars with end caps, chairs and core foam insert.

Photo 21. Dowel bar assemblies are placed into slots.

Photo 22. Dowel bars that have been placed and aligned in slots over a transverse crack.

The foam core insert (closed cell foam with plastic or poster board faced material) should be of sufficient quality to allow a tight fit to all edges of the slot during placement of the concrete patching material. Care should be given to ensure the core foam insert extends beneath the dowel bar to the bottom of the slot; otherwise, separation of the joint is not obtained.

The chairs placed on the dowel bars should be strong enough to allow full support of the dowel bar. Chairs should allow at least a ½ inch clearance between the bottom of the dowel and the bottom of the slot.

End caps should allow at least ¼ inch of movement at each end of the bar.

Photo 23. Dowel bar placement and alignment at a transverse joint.

Photo 24. Dowel bar placement and alignment at a skewed transverse joint.

Photo 25. Epoxy coated dowel bars that had chips and nicks prior to placement. The corrosion, which resulted two years after placement, could have resulted from improper handling.

Dowel bar assemblies should be carefully placed into the slots, according to the required tolerances.

Dowel bars must be centered over the existing crack or transverse joint. The foam core board must be placed in line with the crack or joint. The foam core board should be ½ inch below the top of existing concrete surface.

The foam core insert must be positioned in line with a skewed transverse joint.

Photo 26. Epoxy coated dowel bars that have corroded possibly due to improper handling.

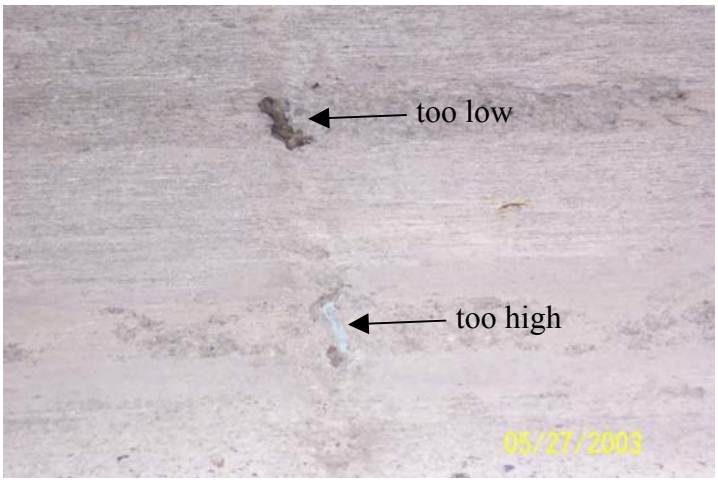


Photo 27. Foam core board placed too high and too low in slot.

6. Placement of Concrete Patching Material

Patching material should be consolidated with a 1 inch or less diameter vibrator as approved by the Engineer

The patching material on the surface of the dowel bar slots should not be overworked, causing segregation and leaving the fine material on the surface. The patching material should be left ⅛ inch to ¼ inch high and not finished flush with the existing concrete surface.

The joint should be maintained by saw cutting the surface with a hand pushed single blade saw. The cut width should be 3/16 to 5/16 inch and the depth 1½ inch. The cut length should be 2½ feet long centered over the three retrofit epoxy-coated dowel bars and should be sawed within 24 hours after placement of the concrete patching material.

Concrete patching material should be placed in a manner that does not cause the movement of the dowel bar within the slot. Concrete patching material should not be dumped onto the slots. Placing the concrete patching material on the surface adjacent to the slot and shoving it towards the slot allows the least movement.

Photo 28. Placing patching material.

Photo 29. Placing patching material.

Photo 30. Shoveling patching material into slots.

Photo 31. Consolidating patching material.

Photo 32. Finishing patching material.

Photo 33. Finished patching material should be left slightly high to minimize fine material at final slot surface.

Photo 34. Completed placement of patching material.

Photo 35. Segregated patching material, which may lead to additional spalling and cracking.

Photo 36. Patching material placed too low, results in poor ride quality and may cause cracking due to insufficient cover on bar.

Photo 37. Patching material was poorly consolidated beneath the dowel bar, which may result in pop out of patching material.

Photo 38. Opening to traffic prior to proper curing of patching material.

7. Diamond Grinding

Pavement grinding should begin within 10 working days of placing dowel bar retrofit patching materials (this minimizes traveler complaints of surface roughness).

Smoothness restoration should be completed via diamond grinding. Diamond grinding cuts into the concrete aggregate to improve the surface and ride. If used, a milling machine will impact the roadway surface, causing joint and crack spalling. Performance has shown that an when a milling machine is used to restore the pavement ride, an unacceptable riding surface results within 3 to 5 years.

Slurry Removal

Removal of the grinding residue from the roadway surface should occur immediately after grinding. Slurry should not be allowed to drain across open traffic lanes and shoulders. Slurry should not be allowed to drain into any waterway, placed on the roadway slope within 200 feet of any waterway, or other areas as designated by the Engineer.

The agencies environmental section should be consulted during the dowel bar retrofit design regarding concrete slurry removal. Some projects will allow slurry to be placed on the roadway slopes while some areas, depending on environmental requirements, will require that the slurry be removed off site. Whether concrete slurry removal is allowed on site or off site, the contractor should be made aware that they are responsible for all costs.

Photo 39. Diamond ground surface. The transverse crack has not been damaged.

Photo 40. Rotomilled surface. The transverse joint has been damaged due to the impact of the rotomill on the concrete.

Photo 41. Processing plant for treating diamond grinding slurry.

WSDOT Standard Specification for Cement Concrete Pavement Rehabilitation

The WSDOT 2002 Standard Specification can be accessed at
http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/2002SS.pdf

5-01 CEMENT CONCRETE PAVEMENT REHABILITATION (available January 2004)

5-01.1 Description

This work shall consist of rehabilitating or replacing section(s) of portland cement concrete pavement in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or established by the Engineer.

5-01.2 Materials

Materials shall meet the following requirements as listed:

Portland Cement	9-01
Fine Aggregate	9-03
Coarse Aggregate	9-03
Combined Aggregate	9-03
Joint Filler	9-04.1
Joint Sealants	9-04.2
Reinforcing Steel	9-07
Dowel Bars	9-07.5
Tie Bars	9-07.6
Concrete Patching Material	9-20
Curing Materials and Admixtures	9-23
Water	9-25
Epoxy Resins (bonding agents)	9-26

Parting Compound shall be a curing compound, grease or other substance approved by the Engineer.

Subsealing

Pozzolan meeting the requirements of AASHTO M 295 may also be used.
Standard Mix Design (by volume) for subsealing is as follows:

1 part Portland cement Type I or II
3 parts pozzolan
2.25 parts water

The Contractor shall supply the Engineer with test reports of the slurry to be used on the project. The Contractor shall use the services of a laboratory that has an equipment calibration/ verification system and a technician training and evaluation process per AASHTO R-18 to conduct all tests. The test reports shall show one, three, and seven-day strengths, flow cone times, and time of initial set. The seven-day compressive strength shall not be less than 600 psi as measured using AASHTO T-106. Time of efflux shall range from 9 to 15 seconds for the cement concrete pavement slabs and 16 to 25 seconds for the cement concrete bridge approach slabs as per ASTM C939.

The Engineer shall approve any deviation from the standard mix design.

Dowel Bar Retrofit

Dowel bar expansion caps shall be tight fitting and made of non-metallic material, which will allow for ¼ inch of movement at each end of the bar.

Chairs for supporting the dowel bar shall be epoxy coated according to Section 9-07.3 or made from non-metallic material.

The foam insert shall be closed cell foam faced with poster board material or plastic faced material on each side commonly referred to as foam core board by office suppliers. The foam insert shall be capable of remaining in a vertical position and tight to all edges during the placement of the concrete patching material.

Caulking filler used for sealing the transverse joint at the bottom and sides of the slot shall be a silicone caulk.

5-01.3 Construction Requirements

5-01.3(1)A Concrete Mix Design for Concrete Patching Materials

1. **Materials**. The prepackaged concrete patching material shall conform to Section 9-20. The aggregate extender shall conform to Section 9-03.1(4)C, AASHTO Grading No. 7. Mitigation for Alkali Silica Reaction (ASR) will not be required for the extender aggregate used for concrete patching material.
2. **Submittals**. The Contractor shall provide a mix design to the Engineer for approval of the concrete patching material to be used. The Contractor's submittal shall include the mix proportions of the prepackaged mix, water, and aggregate extender, and the proposed sources for all aggregate. The Contractor shall use the manufacturer's recommendations to determine the proportions. Mix designs submitted by the Contractor shall include test data confirming that concrete patching material will meet the requirements of section 9-20. The Contractor shall use the services of an accredited laboratory that has an equipment calibration/ verification system and a technician training and evaluation process per AASHTO R-18 to conduct all required tests.

5-01.3(1)B Equipment

In addition to Sections 5-05.3(3)A ,5-05.3(3)B, 5-05.3(3)D and 5-05.3(3)E the following shall apply.

Mobile volumetric mixers shall be calibrated in accordance with Section 6-09.3(1)H. The references to the latex admixture shall not apply.

Air compressors shall be of sufficient size and capacity to perform the work to the satisfaction of the Engineer.

The equipment for grinding cement concrete pavement shall use diamond embedded saw blades gang mounted on a self propelled machine that is specifically designed to smooth and texture concrete pavement. The equipment shall not damage the underlying surface, cause fracture, or spalling of any joints.

All equipment shall be maintained in good condition.

Subsealing

Grout mixers shall consist of a cement injection pump and a high-speed colloidal mixing machine. The colloidal mixing machine shall operate at a minimum speed of 1,200 rpm and shall consist of a rotor operating in close proximity to a stator, creating a high shearing action

and subsequent pressure release to make a homogeneous mixture. Water shall be added to the batch through a meter or scale with a totalizer for the day's consumption.

Wooden cylindrical plugs or other devices approved by the Engineer shall be provided to temporarily plug the application holes until the material has set. The plugs shall be slightly tapered on one end for ease in driving.

5-01.3(2) Material Acceptance

5-01.3(2)A Concrete Patching Material

The concrete patch material shall be as specified in Section 9-20.

5-01.3(2)B Portland Cement Concrete

The point of acceptance will be at the discharge of the placement system.

The concrete producer shall provide a certificate of compliance for each truckload of concrete in accordance with Section 6-02.3(5)B.

Acceptance testing for compliance of air content and 28 day compressive strength shall be conducted from samples obtained according to FOP for WAQTC TM 2. Air content shall be determined by conducting WAQTC FOP for AASHTO T 152. If the Contractor fails to provide the Aggregate Correction Factor per WAQTC FOP for AASHTO T 152 with the mix design, one will not be applied. Compressive Strength shall be determined by WSDOT FOP for AASHTO T 22 and WSDOT FOP for AASHTO T 23.

Rejection of Concrete

Rejection by the Contractor: The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. The replacement material will be sampled, tested and evaluated for acceptance.

Rejection without Testing: The Engineer may reject any load that appears defective prior to placement. Material rejected before placement shall not be incorporated into the pavement. No payment will be made for the rejected materials unless the Contractor requests that the rejected material be tested. If the Contractor elects to have the rejected materials tested, a sample will be taken and both the air content and strength shall be tested by WSDOT.

Payment for rejected material will be based on the results of the one sample, which was taken and tested. If the rejected material fails either test, no payment will be made for the rejected material and in addition, the cost of sampling and testing, at the rate of $250.00 per sample shall be borne by the Contractor. If the rejected material passes both tests the mix will be compensated for at actual invoice cost and the cost of the sampling and testing will borne by the Contracting Agency.

5-01.3(3) Subsealing

Subsealing shall not be done when the pavement is wet, or when water is present under the pavement. The maximum surface temperature for testing and subsealing is 70ºF.

The Contractor shall test all transverse joints through the areas as shown in the Plans.

The testing will determine the need for subsealing. Testing will be accomplished by applying a 9,000 lb load on each side of the joint to measure the vertical movement (along the right lane edge or the edge nearest the shoulder). The testing equipment shall be able to record the information to within 0.001 inch. The Contractor shall submit the method of testing, for approval by the Engineer, prior to commencing work. Testing will be required before and after

the grouting operation. All testing will be conducted when the concrete pavement surface temperature is 70ºF or less, except the Engineer shall stop testing earlier if there is evidence of slab lockup due to thermal expansion or as required by other traffic control plans. To determine the location of subsealing, both the leave and approach outside corner of the slab will be tested. Any slab exhibiting a deflection greater than 0.025 inch will be subsealed.

If the slab deflection is greater than 0.025 inch after the initial grouting, a second grouting and third test shall be performed. If the third test fails, the Engineer will make a determination whether to re-grout a third time or to remove the slab.

During the subsealing operation, a positive means of monitoring lift which is accurate to within 0.001 inch, as approved by the Engineer, shall be used. The upward movement of the pavement shall not be greater than 0.025 inch. The maximum allowable pressure for the subseal operation shall not exceed 100 pounds per square inch, except that a short surge of 300 pounds per square inch will be allowed when starting to pump the hole in order for the grout to penetrate into the void structure. The pressure shall be monitored by an accurate pressure gauge in the grout line that is protected from the grout slurry. Water displaced from the void structure by grout shall be allowed to flow freely. Excessive loss of the grout through cracks, joints, or from back pressure in the hose or in the shoulder area will not be allowed.

5-01.3(4) Replace Portland Cement Concrete Panel

Curing, cold weather work, concrete pavement construction in adjacent lanes, and protection of pavement shall meet the requirements of Section 5-05.3.

Concrete slabs to be replaced as shown in the Plans or staked by the Engineer shall be at least 6.0 feet long and full width of an existing pavement panel. The portion of the panel to remain in place shall have a minimum dimension of 6 feet in length and full panel width; otherwise the entire panel shall be removed and replaced. There shall be no new joints closer than 3.0 feet to an existing transverse joint or crack. Vertical saw cutting full pavement depth is required along all longitudinal joints and at transverse locations. Removal of existing cement concrete pavement shall not cause damage to adjacent slabs that are to remain in place. The Contractor, at no cost to the Contracting Agency, shall repair any damage caused by the Contractor's operation. In areas that will be ground, slab replacements shall be performed prior to pavement grinding.

When new concrete pavement is to be placed against existing cement concrete pavement, epoxy coated tie bars and epoxy coated dowel bars shall be drilled and grouted into the existing pavement with epoxy resin, type I or IV as specified in Section 9-26. Tie bars are not required for panel replacements less than a full panel.

Dowel bars shall be placed at the mid depth of the concrete slab, centered over the transverse joint, and parallel to the centerline and to the roadway surface.

Placement tolerances for dowel bars

1. ± 1 inch of the middle of the concrete slab depth.
2. ± 1 inch of being centered over the transverse joint.
3. ± ½ inch from parallel to the centerline.
4. ± ½ inch from parallel to the roadway surface.

Dowel bars may be adjusted to avoid contact with existing dowel bars in the transverse joint at approach slabs or existing panels without exceeding specified tolerances.

Tie bars shall be placed at the mid depth of the concrete slab, centered over the joint, perpendicular to centerline, and parallel to the roadway surface.

Placement tolerances for tie bars

1. ±1 inch of the middle of the concrete slab depth.
2. ±1 inch of being centered over the joint.
3. ±1 inch from perpendicular to the centerline.
4. ±1 inch from parallel to the roadway surface.

The horizontal position of tie bars may be adjusted to avoid contact with existing tie bars in the longitudinal joint where panel replacement takes place.

Dowel bars and tie bars shall be placed according to the Standard Plan when multiple panels are placed.

Panels shall be poured separately from the bridge approach slab.

Dowel bars to be drilled into existing concrete or at a new transverse contraction joint shall have a parting compound, such as curing compound, grease, or other Engineer approved equal, applied to them prior to placement.

The tie bar and dowel bar holes shall be blown clean with compressed air before grouting. The bar shall be centered in the hole for the full length of embedment before grouting. The grout shall then be pumped into the hole around the bar in a manner that the back of the hole will be filled first. Blocking or shimming shall not impede the flow of the grout into the hole. Dams, if needed, shall be placed at the front of the holes to confine the grout. The dams shall permit the escape of air without leaking grout and shall not be removed until grout has cured in the hole.

The Contractor shall smooth the surfacing below the removed panel and compact it to the satisfaction of the Engineer. Crushed surfacing base course, or asphalt concrete pavement may be needed to bring the surfacing to grade prior to placing the new concrete. If the material under the removed panel is uncompactable and the Engineer requires it, the Contractor shall excavate the subgrade two feet, place a soil stabilization construction geotextile meeting the requirements of Section 9-33, and backfill with crushed surfacing base course.

Side forms shall meet the requirements of Section 5-05.3(7)B whenever a sawed full depth vertical face cannot be maintained.

The Contractor shall place polyethylene film in accordance with AASHTO M 171 along all existing concrete surfaces and between the bottom of the slab and treated bases prior to placing concrete.

Grade control shall be the responsibility of the Contractor.

All panels shall be struck off level with the adjacent panels and floated to a smooth surface.

Final finish texturing shall meet the requirements of section 5-05.3(11).

In areas where the Plans do not require grinding, the surface smoothness will be measured with a 10-foot straightedge by the Engineer in accordance with Sections 5-05.3(12). If the replacement panel is located in an area that will be ground as part of portland cement concrete pavement grinding in accordance with Section 5-01.3(9), the surface smoothness shall be measured, by the Contractor, in conjunction with the smoothness measurement done in accordance with Section 5-01.3(10).

All transverse and longitudinal joints shall be sawed and sealed in accordance with Section 5-05.3(8). The Contractor may use a hand pushed single blade saw for sawing joints.

Portland cement concrete shall meet the criteria of Sections 5-05.3(1), 5-05.3(2) and 5-05.3(5)A. Where accelerated pavement construction is required the Contractor may use concrete patching materials for panel replacement as specified in Section 9-20.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

5-01.3(5) Partial Depth Spall Repair

Removal of the existing pavement shall not damage any pavement to be left in place. Any existing pavement that is to remain that has been damaged shall be repaired at the Contractor's expense. If jackhammers are used for removing pavement, they shall not weigh more than 30 pounds, and chipping hammers shall not weigh more than 15 pounds. All power driven hand tools used for the removal of pavement shall be operated at angles less than 45 degrees as measured from the surface of the pavement to the tool. The patch limits shall extend beyond the spalled area a minimum of 3.0 inches. Repair areas shall be kept square or rectangular. Repair areas that are within 12.0 inches of another repair area shall be combined.

A vertical saw cut shall be made to a minimum depth of 3.0 inches around the area to be patched as marked by the Engineer. The Contractor shall remove material within the perimeter of the saw cut to a depth of 3.0 inches, or to sound concrete as determined by the Engineer. Repair depths that exceed one third of the total slab shall require full depth repair.

The surface patch area shall be sand blasted and all loose material removed. All sandblasting residue shall be removed using dry oil-free air.

Spall repair shall not be done in areas where dowel bars or heavy reinforcing steel are encountered.

When a partial depth repair is placed directly against an adjacent longitudinal joint, polyethylene film shall be placed between the existing concrete and the area to be patched.

Patches that abut working transverse joints or cracks require placement of a compressible insert. The new joint or crack shall be formed to the same width as the existing joint or crack. The compressible joint material shall be placed into the existing joint 1.0 inch below the depth of repair. The compressible insert shall extend at least 3.0 inches beyond each end of the patch boundaries.

Patches that abut the lane/shoulder joint require placement of a formed edge, along the slab edge, even with the surface.

The patching material shall be mixed, placed, consolidated, finished and cured according to manufacturer's recommendations. Slab/patch interfaces that will not receive pavement grinding shall be sealed (painted) with a 1:1 cement-water grout along the patch perimeter.

The Contractor shall reseal all joints in accordance with Section 5-05.3(8)B.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

5-01.3(6) Dowel Bar Retrofit

Dowel bars shall be installed in the existing concrete pavement joints and transverse cracks where shown in the Plans or as marked by the Engineer.

Saw cut slots will be required in the pavement to place the center of the dowel at mid-depth in the concrete slab. The completed slot shall provide a level, secure surface for the feet of the dowel bar chairs. Slots that intersect longitudinal or random cracks shall not be retrofitted. When gang saws are used, slots that are not used shall be cleaned and sealed with an epoxy resin, type I or IV. The epoxy resin shall conform to the requirements of Section 9-26. The transverse joint between Portland Cement Concrete Pavement and a Bridge approach slab shall not be retrofitted.

Saw cut slots shall be prepared such that dowel bars can be placed at the mid depth of the concrete slab, centered over the transverse joint, and parallel to the centerline and to the roadway surface.

Placement tolerances for dowel bars

1. ± 1 inch of the middle of the concrete slab depth.
2. ± 1 inch of being centered over the transverse joint.
3. ± ½ inch from parallel to the centerline.
4. ± ½ inch from parallel to the roadway surface.

If jackhammers are used to break loose the concrete they shall weigh less than 30 pounds.

All exposed surfaces and cracks in the slot shall be sand blasted and cleaned to bare concrete to remove slurry, parting compound, or other foreign materials prior to installation of the dowel. Traffic shall not be allowed on slots where concrete has been removed.

Prior to placement, the dowel bars shall be lightly coated with a parting compound and placed on a chair that will provide a minimum of ½ inch clearance between the bottom of the dowel and the bottom of the slot.

The chair design shall hold the dowel bar tightly in place during placement of the concrete patching material. Immediately prior to placement of the dowel bar and concrete patching material, the Contractor shall caulk the transverse joint or crack at the bottom and sides of the slot as shown in the Plans. The caulking filler shall not be placed any farther than ½ inch outside either side of the joint or crack. The transverse joint or crack shall be caulked sufficiently to satisfy the above requirements and to prevent any of the patching material from entering the joint/crack at the bottom or sides of the slot.

A 3/8-inch thick foam insert shall be placed at the middle of the dowel to maintain the transverse joint. The foam insert shall fit tightly around the dowel and to the bottom and edges of the slot and be a minimum of 1½ inch below the existing concrete surface. The foam insert shall be capable of remaining in a vertical position and held tightly to all edges during placement of the patch. If for any reason the foam insert shifts during placement of the patch the work shall be rejected and redone at the Contractor's expense.

Patching material shall be consolidated by using a 1.0-inch or less diameter vibrator as approved by the Engineer. The Contractor shall not overwork the patching material during the patch consolidation process.

The patching material on the surface of the dowel bar slots shall not be overworked, causing segregation and leaving the fine material on the surface. The patching material shall be left ⅛ inch to ¼ inch high and not finished flush with the existing concrete surface.

The joint shall be maintained by saw cutting the surface with a hand pushed single blade saw. The cut width shall be 3/16 to 5/16 inch and the depth 1½ inches. The cut length shall be 2½ feet long centered over the three retrofit epoxy-coated dowel bars and shall be sawed within 24 hours after placement of the concrete patching material.

5-01.3(7) Sealing Existing Concrete Random Cracks

The Contractor shall route, clean and seal existing concrete random cracks where indicated by the Engineer. Cracks smaller than 5/16 inch in width shall be routed to 5/16 inch wide by 1 inch deep prior to placing the sealant. Cracks over 5/16 inch in width shall be cleaned and sealed.

All incompressible material shall be completely removed from the existing random crack to a depth of ¾ inch. Immediately prior to sealing, the cracks shall be blown clean with dry, oil free compressed air.

The top surface of the sealant shall be at least ¼ inch below the surface of the pavement.

5-01.3(8) Sealing Existing Transverse and Longitudinal Joints

The Contractor shall clean and seal existing transverse and longitudinal joints where shown in the Plans or as marked by the Engineer.

Old sealant and incompressible material shall be completely removed from the joint to the depth of the new reservoir with a diamond blade saw. The removed sealant shall become the property of the Contractor and be removed from the jobsite.

Removal of the old sealant for the entire depth of the joint is not required if the depth of the new reservoir is less than the depth of the existing joint.

Joints constructed with joint tape do not require cleaning and sealing.

Immediately prior to sealing, the cracks shall be blown clean with dry oil-free compressed air. The joints shall be completely dry before the sealing installation may begin. Immediately following the air blowing, the sealant material shall be installed in conformance to manufacturer's recommendations and in accordance with Section 5-05.3(8)B.

The top surface of the sealant shall be at least ¼ inch below the surface of the pavement.

5-01.3(9) Portland Cement Concrete Pavement Grinding

Pavement grinding shall begin within 10 working days of placing dowel bar retrofit patching materials. Once the grinding operation has started it shall be continuous until completed. The right travel lane in the direction of traffic shall be ground first.

The pavement shall be ground in a longitudinal direction beginning and ending at lines normal to the pavement centerline. The minimum overlap between longitudinal passes shall be 2.0 inches. 95% of the surface area of the pavement to be ground shall have a minimum of 1/8 inch removed by grinding.

Removal of the grinding residue from the roadway shall occur immediately after grinding and shall be accomplished on a continual basis. Slurry shall not be allowed to drain across open traffic lanes and shoulders. Slurry shall not be allowed to drain into any waterway, placed on the roadway slope within 200 feet of any waterway, or other areas as designated by the Engineer. Prior to commencing the grinding operation, the Contractor shall submit to the Engineer for approval a plan to prevent contaminants, such as grinding slurry or concrete debris, from entering ditches, culverts, or other waterways, including wetlands or aquifers.

Prior to opening to traffic, the Contractor shall remove any grindings and dust from the ground pavement by washing and/or brooming to the satisfaction of the Engineer.

Concrete slurry shall be collected from the roadway and disposed of by the

Contractor off the project site. The Contractor shall provide a copy of the permit for an approved waste site for the disposal of the slurry prior to the start of the grinding.

Bridge decks, bridge approach slabs and bridge overlay insets shall not be ground.

The ground pavement shall be feathered to match the elevation of the above features.

5-01.3(9)A Surface Finish

The final surface texture shall be uniform in appearance with longitudinal corduroy type texture. The grooves shall be between 3/32 and 5/32 inches wide, and no deeper than 1/16 inch. The land area between the grooves shall be between 1/16 and ⅛ inches wide.

5-01.3(10) Pavement Smoothness

Section 5-05.3(12) is supplemented with the following:

Where the pavement is ground, calculation of the profile index shall exclude dips and depressions in the existing roadway. The profilograph generated reports shall be provided to the Engineer prior to payment.

5-01.4 Measurement

Testing cement concrete pavement slabs for subsealing will be measured per each transverse joint, for each traffic lane tested. Measurement of this item will be made only once and will not be measured again after necessary retesting.

Pavement subseal will be measured by the cubic foot of dry materials.

Retrofit dowel bars will be measured per each for the actual number of bars used in the completed work.

Cement concrete pavement grinding will be measured by the square yard, based on the actual width and length of area ground. Extra passes to meet the specifications or overlaps will not be measured.

5-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Testing Cement Concrete Pavement Slabs For Subsealing", per each.

The unit contract price per each, when multiplied by the number of units measured, shall be full payment for all costs to complete the testing of all joints located in the areas shown in the Plans. The costs of any retesting required by the specifications shall also be included.

"Drill Hole for Subsealing", per each.

"Pavement Subseal", per cubic foot.

"Replace Cement Concrete Panel", per square yard.

The unit contract price per square yard shall be full payment for all costs to complete the work as specified, including saw cutting full depth, removal and disposal of the existing panels off of the State's right-of-way, preparing the surfacing below the new panel, provide, place and compact the crushed surfacing or asphalt concrete pavement, excavation, construction geotextile, placement and compaction of crushed surfacing base course, furnishing and placing polyethylene film, furnishing and placing the portland cement concrete, drilling the holes, providing, and anchoring the dowel bars and tie bars, and for all incidentals required to complete the work as specified.

"Retrofit Dowel Bars", per each.

The unit contract price per each shall be full payment for all costs to complete the work as specified, including furnishing and installing parting compound, dowel bar expansion caps, caulking filler, foam core insert material, cement patch where pavement is removed for dowel bar retrofit and for all incidentals required to complete the work as specified.

"Partial Depth Spall Repair", by force account as provided in Section 1-09.6.

To provide a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Sealing Existing Concrete Random Crack", per linear foot.

The unit contract price per linear foot for "Sealing Existing Concrete Random Crack" shall be full payment for all costs to complete the work as specified, including removing incompressible material, preparing and sealing existing random cracks where existing random cracks are cleaned and for all incidentals required to complete the work as specified.

"Sealing Transverse and Longitudinal Joints", per linear foot.

The unit contract price per linear foot for “Sealing Transverse and Longitudinal Joints”, shall be full payment for all costs to complete the work as specified, including removing incompressible material, preparing and sealing existing random cracks where existing random cracks are cleaned and for all incidentals required to complete the work as specified.

“Cement Concrete Pavement Grinding”, per square yard.

The unit contract price per square yard for “Cement Concrete Pavement Grinding”, when multiplied by the number of units measured, shall be full payment for all costs to complete the work as specified. The costs of any additional pavement grinding, profiling, removal and disposing of slurry required to complete the work as specified is also included in this payment.

SECTION 9-20, CONCRETE PATCHING MATERIAL (August 4, 2003)

9-20.1 Patching Material

Concrete patching materials will be prepackaged patching grout or mortar extended with aggregate. The amount of aggregate for extension shall conform to the manufacturer's recommendation. This material may be used for partial depth spall repair, panel replacement and dowel bar retrofit.

9-20.2 Specifications

Prepackaged patching materials (mortar) and extended patching materials (concrete) shall be cementious material and meet the following requirements:

Characteristics	Test Method	Requirements
Patching Mortar & Grout		
Compressive Strength		
at 3 hours	ASTM C-109	Minimum 3,000 psi
at 24 hours	ASTM C-109	Minimum 5,000 psi
Length Change		
at 28days	ASTM C-157	0.15 percent maximum
Total Chloride Ion Content	ASTM C-1218	1 lb/yd^3 maximum
Bond Strength		
at 24 hours	ASTM C-882 (As modified by ASTM C-928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	ASTM C-672 (As modified by ASTM C-928, Section 8.4)	1 lb/ft^2 maximum
Extended Aggregate Concrete from Mortar or Grout		
Compressive Strength		
at 3 hours	ASTM C-39	Minimum 3,000 psi
at 24 hours	ASTM C-39	Minimum 5,000 psi
Length Change		
at 28days	ASTM C-157	0.15 percent maximum
Bond Strength		
at 24 hours	ASTM C-882 (As modified by ASTM C-928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	ASTM C-672	2 Maximum Visual Rating
Freeze thaw	ASTM C 666	Maximum expansion 0.10% Minimum durability 90.0%

Aggregate for extension material shall meet the requirements of Section 9-03.1(4) and be AASHTO Grading No. 7.
Water shall meet the requirements of Section 9-25.1. The quantity of water shall be within the limits recommended by the manufacturer.

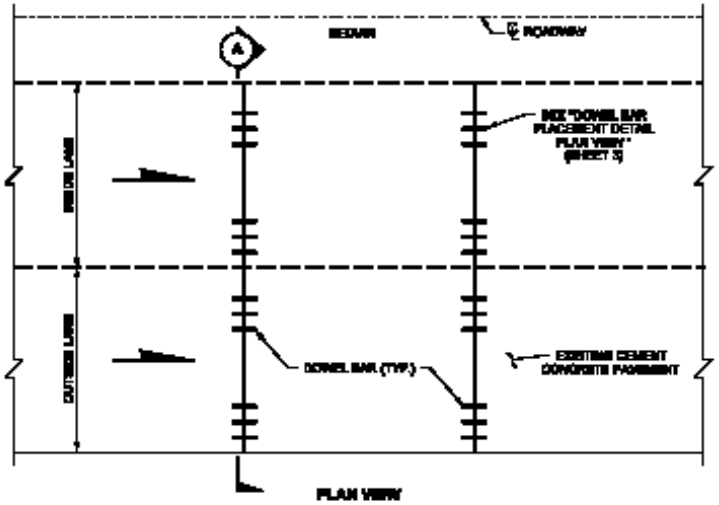
9-20.3 Approval, Acceptance and Submittals

Approval for the extended concrete patching material shall be based on acceptable compressive strength results submitted with the concrete patch material mix design.

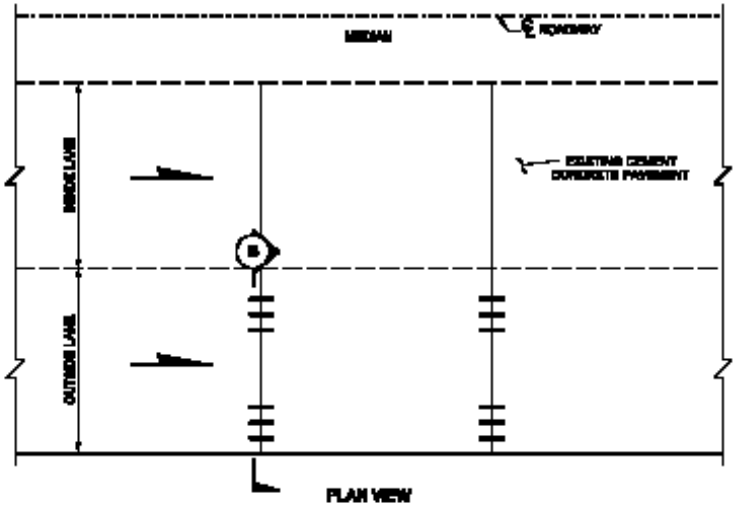
Approval for the aggregate extender shall be based on that it is from an approved source, has a satisfactory gradation report supplied with the mix design, and a Manufacturer's Certificate of Compliance that the gradation meets AASHTO #7.

Prior to the start of placing concrete patching material the Contractor shall submit a mixing plan to the Engineer for approval.

Acceptance shall be based on field verification of the prepackage patching material, and that the amount of added water and aggregate extender complies with the mix design.

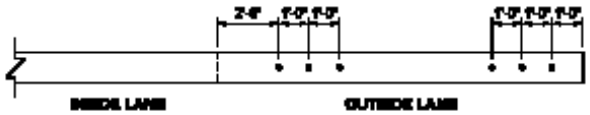


DIVIDED HIGHWAY
(ONE WAY TRAFFIC)
DOWEL BAR RETROFIT
FOR TWO LANES



DIVIDED HIGHWAY
(ONE WAY TRAFFIC)
DOWEL BAR RETROFIT
FOR ONE LANE

SECTION A



SECTION B

EXPIRES JULY 27, 2003

DOWEL BAR RETROFIT FOR CEMENT CONCRETE PAVEMENT

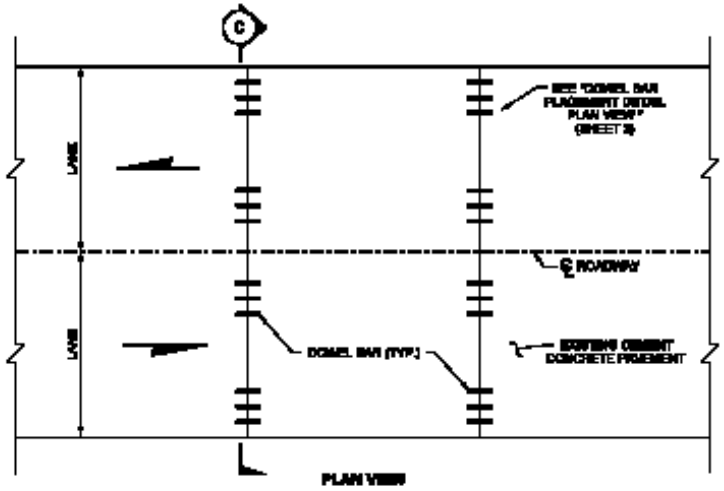
STANDARD PLAN A-5

(SHEET 1 OF 3 SHEETS)

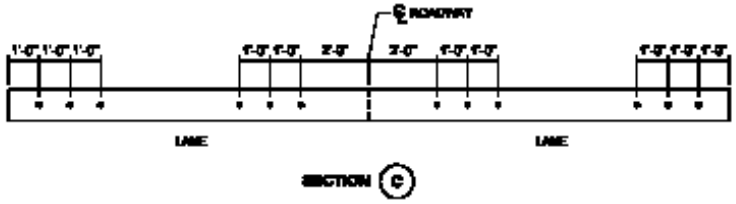
APPROVED FOR PUBLICATION

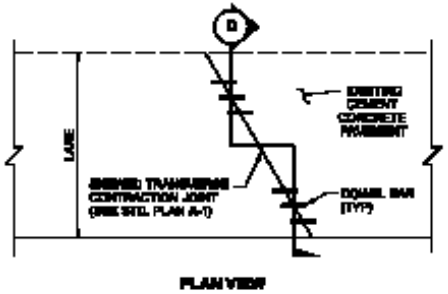
Harold J. Peterson 03-26-03

Washington State Department of Transportation

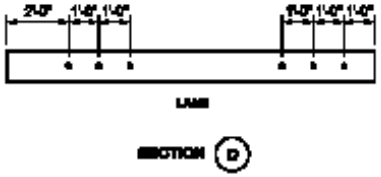


UNDIVIDED HIGHWAY
(TWO WAY TRAFFIC)
DOWEL BAR RETROFIT
FOR EACH LANE





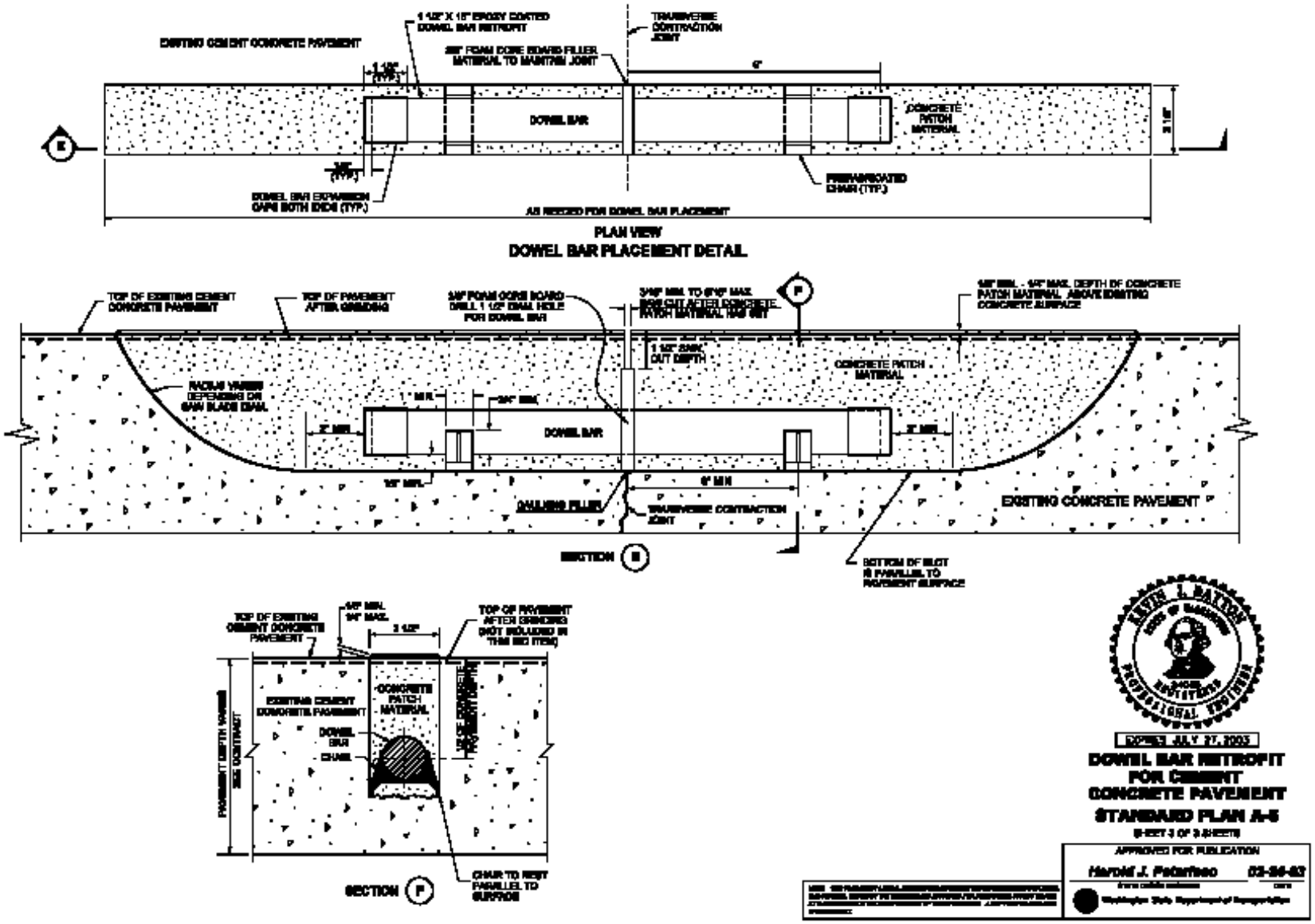
SKEWED JOINT DETAIL

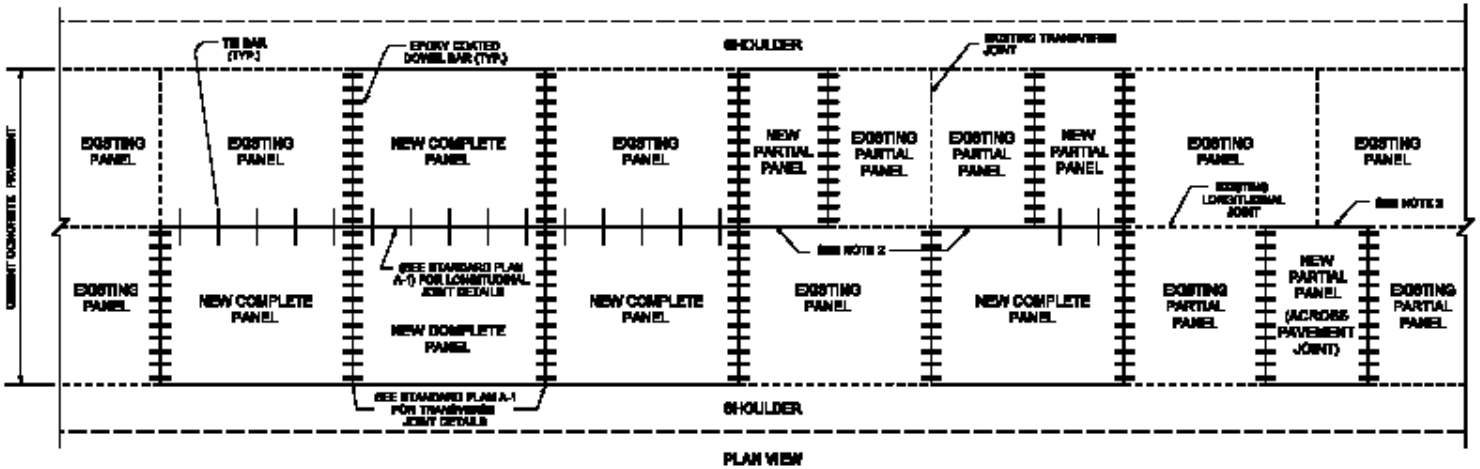


DOWEL BAR RETROFIT
FOR CEMENT
CONCRETE PAVEMENT
STANDARD PLAN A-5

APPROVED FOR PUBLICATION

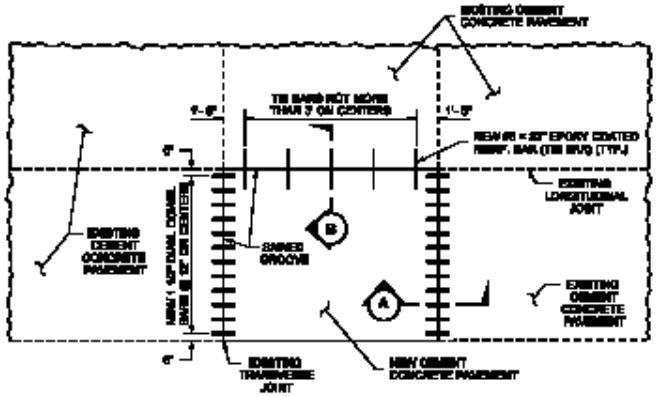
Harold J. Peterson 03-26-03


EXISTING CEMENT CONCRETE PAVEMENT
TRANSVERSE CONTRACTION JOINT
DOWEL BAR
CONCRETE PATCH MATERIAL
PREFABRICATED CHAIR (TYP.)
AS NEEDED FOR DOWEL BAR PLACEMENT
PLAN VIEW
DOWEL BAR PLACEMENT DETAIL
TOP OF EXISTING CEMENT CONCRETE PAVEMENT
TOP OF PAVEMENT AFTER GRINDING
CONCRETE PATCH MATERIAL
DOWEL BAR
EXISTING CONCRETE PAVEMENT
TRANSVERSE CONTRACTION JOINT
SECTION B
BOTTOM OF SLOT IS PARALLEL TO PAVEMENT SURFACE
TOP OF EXISTING CEMENT CONCRETE PAVEMENT
TOP OF PAVEMENT AFTER GRINDING (NOT INCLUDED IN THIS BID ITEM)
CONCRETE PATCH MATERIAL
EXISTING CEMENT CONCRETE PAVEMENT
DOWEL BAR
CHAIR
CHAIR TO REST PARALLEL TO SURFACE
SECTION F
DOWEL BAR RETROFIT FOR CEMENT CONCRETE PAVEMENT
STANDARD PLAN A-5
APPROVED FOR PUBLICATION
Harold J. Petersen
03-24-03



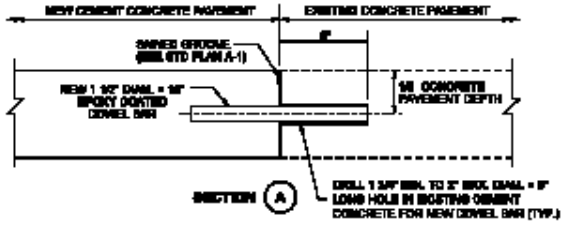
PLAN VIEW

PANEL REPLACEMENT



PLAN VIEW

COMPLETE PANEL REPLACEMENT



NOTES

1. Install tie bars along longitudinal joint between full panel replacement and existing cement concrete pavement. Tie bars are not installed between cement concrete pavement and asphalt concrete shoulder.
2. Place polyethylene film (per AASHTO M 171-00) along the longitudinal joint between partial panel replacement and existing panel.

EXPIRES JULY 27, 2003

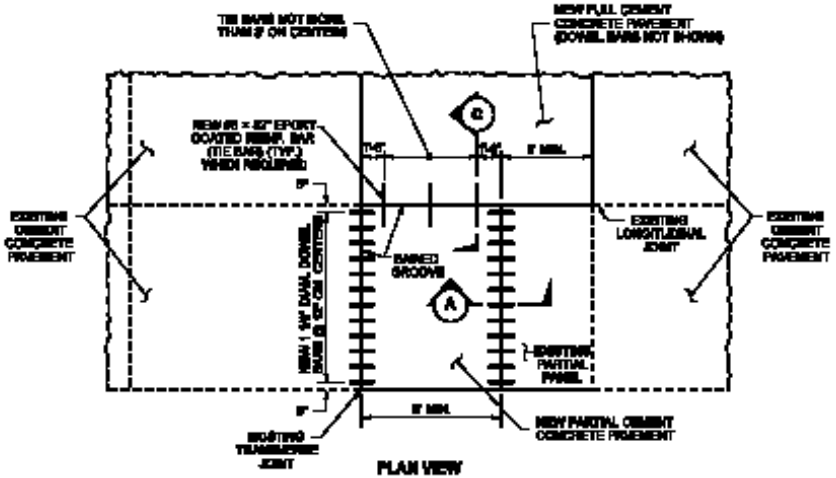
CURRENT CONCRETE PAVEMENT REPAIR

STANDARD PLAN A-8

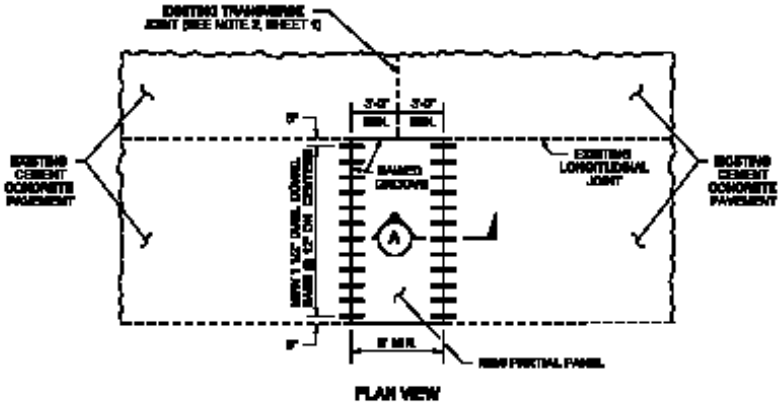
(SHEET 1 OF 2 SHEETS)

APPROVED FOR PUBLICATION

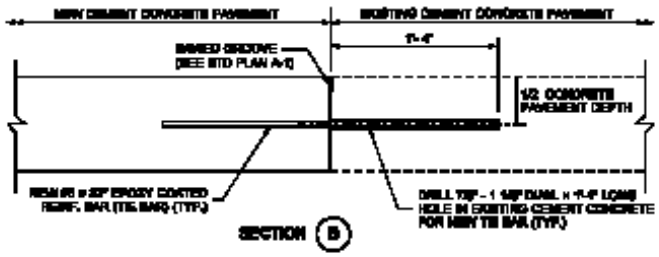
Harold J. Petersen 03-26-03

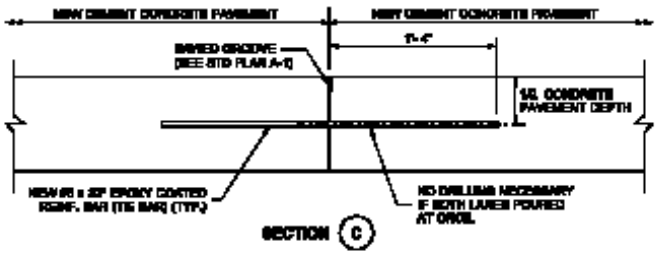


PARTIAL PANEL REPLACEMENT WITH TIE BARS



PARTIAL PANEL REPLACEMENT WITHOUT TIE BARS





CEMENT CONCRETE PAVEMENT REPAIR

STANDARD PLAN A-6

(SHEET 2 OF 2 SHEETS)

APPROVED FOR PUBLICATION

Harold J. Peterson 03-26-03