General Guidelines for Evaluating Random Cracks in New Concrete Pavement

New concrete pavement panels having random cracks shall be repaired or removed and replaced in accordance with the guidelines in this document.

The repair or removal and replacement of panels shall be accomplished at no cost to the Department.

New Portland cement concrete pavement (PCCP) exhibiting random cracks will be visually surveyed by staff from the District and the Materials and Research Division PCC Section. Attachment A presents a sample of a report that is generated from the M&R PCC Section following this field survey.

PCCP panels having random cracks shall be removed and replaced in accordance with the requirements for "CONCRETE PAVEMENT REPAIR" presented in Attachment B. However, PCCP panels having random cracks may be repaired based on the following guidelines:

- Cross-stitching can be used in lieu of full-depth repair work for transverse cracks in concrete pavement panels.

- Cross-stitching can be used in lieu of full-depth repair work for concrete pavement panels having longitudinal cracks which:
    - extend the full-length of the panel ***and***
    - are from 16 to 30 inches (measured laterally) from the adjacent longitudinal joint, ***or***
    - are within 18 inches (measured laterally) of the center of the driving lane, ***or***
    - are not within an obvious wheel path.

Cracks repaired by cross-stitching shall be free of excessive spalls or radial cracks. All cross-stitching shall be performed in accordance with the requirements for "CROSS STITCHING" presented in Attachment B.

Cross-stitched cracks, as well as any other cracks that are in the affected panel, shall have an epoxy penetrating sealer applied to them. The sealant shall be one published on the "NDOR Approved Products List." The sealant shall be applied following the stitching operations and shall be applied in accordance with the manufacturer's recommendations.

An epoxy penetrating sealant will also be required where minor cracks have occurred in pavement that is expected to receive very little or no traffic (such as median surfacing). The sealant shall be as specified in the preceding paragraph.

The cross-stitching or sealing work should be completed during the same construction season as the field survey to minimize further deterioration of the concrete panels. Panels which are allowed to go through a winter after the field survey without being cross-stitched or sealed will need to be re-evaluated when weather permits during the next construction season to determine if cross-stitching or sealing remains the appropriate repair strategy.

Full depth removals (repairs) shall be made in accordance with the requirements in Attachment B. It should be noted that Class PR1 and Class PR3 concrete are not allowed. Smoothness of the pavement repairs shall be subject to the requirements of the contract, *except* that a 10-foot straightedge may be used to evaluate repair sections having an overall length of 25 feet or less. The deviation of the repaired pavement surface – when evaluated using the 10-foot straight edge

– shall not exceed 1/8-inch in 10 feet, including the transition between the repair and the adjacent concrete pavement. Deviations exceeding this limit shall be diamond ground in accordance with the requirements in the contract.

This removal or repair work may be made prior to opening the affected pavement to traffic. However, the opening of pavement to traffic shall not be delayed solely for the purpose of making any of the repairs. Therefore, repairs not made prior to the opening to traffic shall be made under traffic-maintained conditions. All traffic control, pavement marking, and all incidental work associated with these repairs shall be provided at no cost to the Department.

Exemptions

Exemptions from these requirements ***may*** be made for irregularly shaped concrete pavement panels that are typical of intersections and driveways. For the purpose on this guideline, an irregularly shaped panel is defined as one that is ***not:***

- A square or a rectangle with a length to width (or width to length) ratio less than 2.1.
- A four- (or more) sided panel having one or more acute angles greater than 75 degrees.
- A four- (or more) sided panel having an average length to average width (or an average width to average length) ratio that is less than 1.5.

Only panels that are defined as having an irregular shape can be exempted from these requirements. Furthermore, these panels can only be exempted if – in the opinion of the Department – they have an inadequate shape that might have contributed to the development of the random crack.

Panels that are determined to be “exempt” may still require repair, including removal and replacement. However, the costs associated with all or parts of this work shall be negotiated (when unit prices for the work do not exist in the contract) and shall be paid to the Contractor. Payments to the Contractor will include any costs for temporary traffic control, pavement marking, or incidental work associated with these removals or repairs unless the same has already been provided for similar work being performed at the Contractor’s expense.

Attachment A

Longitudinal	Transverse	Station		Westbound			Full Depth Repairs	Stitching Cracks
		From	To	Passing Lane	Driving Lane	Left Turn Lane		
X		751+84	751+68	X			16.5 x 12	
X		751+68	751+35		X		16.5 x 12	
		751+68	751+35	X			16.5 x 12	
X		751+35	751+19		X		16.5 x 12	
X		751+19	750+70		Driving Lane			49.5’
X		750+70	750+37		Inside Edge		33.0 x 12	
	X	615+56.5		X	X			24.0’
--	--	461+56	461+52		corner crack		15 x 16.5	

Attachment B

NH-275-5(137) CN 31417 US-275, Norfolk West

CROSS STITCHING

DESCRIPTION

This work shall consist of strengthening the pavement structure by cross stitching the longitudinal and diagonal cracks and longitudinal joints in areas, as shown in the plans, or designated by the Engineer. The work shall include drilling the holes, placing the new tie bars, and filling the holes with epoxy adhesives.

LOCATION OF DRILL HOLES

For longitudinal cracks the drill holes for the deformed bars shall be placed on alternating sides of the crack and joint at 12 inch centers. The spacing between the stitches shall not be more than 18 inches and less than 6 inches. The cross stitch bars shall not be installed within 4 inches of an existing tie bar or within 12 inches of a transverse joint.

EQUIPMENT

The equipment must be approved by the Engineer. The drill used shall be hydraulic or pneumatic, with vacuum removal of drill dust. The drill shall be mounted in a frame which shall hold the drill at a 35 degree angle. The drill shall not be hand held.

MATERIAL

Bars shall be No. 5, deformed, of the length “L” required for the depth of the pavement “T” as shown in the attached detail. The bars shall conform to the requirements of Section 1020 in the 2007 Standard Specifications.

A Grade 3 Epoxy Adhesive shall be from the approved products list and shall be used in accordance with Section 1018 of the Standard Specifications.

CONSTRUCTION

Cross Stitching Concrete Pavement – as illustrated in the attached detail – shall be accomplished by:

(1) Drilling a 1 inch diameter hole at a 35 degree angle from the horizontal which intersects the crack at the midpoint of the slab.

(2) The drill hole shall be started at approximately distance “X” from the crack and joint as shown in the table.

(3) The hole shall be drilled to a depth “D” indicated in the table.

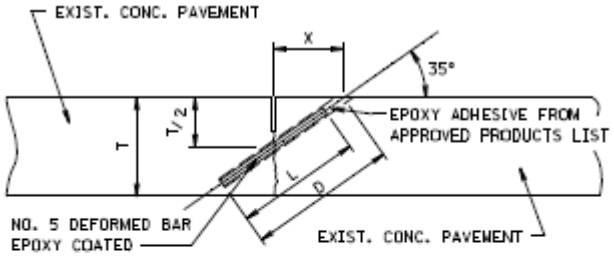
(4) Prior to placing the epoxy material, the drill hole shall be cleaned of all drilling dust.

(5) The drill hole shall be filled with enough epoxy so that when the bar is placed, the epoxy shall completely cover the bar.

Attachment B

(1) The deformed bar of length “L” shown in the table shall be installed in the hole and seated.

(2) The hole shall then be filled with epoxy until it is flush with the surface of the concrete pavement.



DETAILS OF CROSS STITCHING
EXISTING CONCRETE PAVEMENT
(SEE SHEET 2S FOR LOCATIONS)

"T"	"X"	"D"	"L"
8.0"	5.7"	11.9"	9.8"
9.0"	6.5"	13.5"	11.5"
10.0"	7.0"	14.0"	12.5"
11.0"	8.0"	16.0"	13.0"
12.0"	8.5"	17.5"	14.0"
13.0"	9.5"	20.0"	18.0"
14.0"	10.0"	21.0"	18.0"

Note: Deformed Bars shall be 1-inch below the surface.

Full-Depth concrete pavement repairs shall be made in accordance with the requirements of plans, Section 605 in the ***2007 edition*** of the NDOR Standard Specifications for Highway Construction with the amendments listed in the following section entitled "Concrete Pavement Repair.

CONCRETE PAVEMENT REPAIR

Description

1. This work shall consist of repairing portland cement concrete pavement at the locations shown in the plans or as designated by the Engineer. The work shall include removing deteriorated concrete, disposing of the old concrete, preparation of the repair area, and furnishing, placing, finishing, and curing the concrete for the repairs.

2. Full width pavement panels shall be a minimum of 4 feet (2 m) in length.

3. Full depth pavement repair shall be constructed on a prepared subgrade or foundation course as prescribed in the plans. The thickness of the new concrete pavement will be as shown in the plans or the thickness of the adjacent pavement, as appropriate.

4. Special Prosecution:

a. When performing this operation on 2-lane roadways, the Contractor will be required to have all lanes open to traffic before sunset and at times when the Contractor is not working. Where the pavement has been removed and the Contractor will be unable to complete the required patching in time for the concrete to obtain the full curing time required prior to opening the section of the

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road to traffic, the excavation shall be filled with a commercially available cold-mix bituminous mixture, or other suitable temporary patch material with a durable surface, as directed by the Engineer. The Contractor will be required to maintain normal traffic flow across these patches while they are in service. Where it has been necessary to use these "temporary patches", they should normally be removed, the excavation cleaned out, and the required permanent patch placed, within 48 hours.

b. When performing this operation on multi-lane highways, the Contractor will be permitted to have one lane closed at night. Where the pavement has been removed, the Contractor will be required to have the excavated area filled with either (1) the appropriate patching concrete material for curing overnight, or (2) a commercially available cold-mix bituminous mixture or other suitable temporary patch material with a durable surface, as directed by the Engineer. The next day, the Contractor will then be required to remove any “temporary patches”, thoroughly clean the repair area and complete the required permanent patch so that the lane can be opened to traffic by the end of the second day.

Material Requirements

1. Repairs shall be made with Class 47B-3500 or 47bHE-3500 concrete.

2. All materials shall be furnished by the Contractor and shall conform to the requirements in Table 1.

Table 1

Material Requirements	
Applicable Materials	**Section***
Portland Cement Concrete	1002
Curing Compounds (Without Asphalt Overlay)	1012
Curing Compounds (With Asphalt Overlay)	1013
Joint Sealing Filler	1014
Admixtures	1007
Water	1005

* of the 2007 edition of the NDOR Standard Specifications for Highway Construction

Equipment

1. A mobile mixer conforming to the requirements of Section 1002 of the Standard Specifications may be used.

2. Adequate hand tools shall be provided, including an internal vibrator.

3. Vibrating screeds, either mechanical or hand operated, shall be used to finish the concrete.

Construction Methods

1. a. The Contractor shall remove the concrete pavement without damaging the adjacent concrete pavement.

b. All transverse joints shall be reconstructed at the same locations and shall be reinforced as required by the plans

c. The Contractor shall use a diamond blade to make a full depth cut around the perimeter of the repair area.

d. The Contractor shall use hand or pneumatic tools to remove the concrete pavement. If the patch is full depth having an area greater than 15 S.Y. or more, then a drop hammer may be used to break the concrete in order to facilitate the remove the pavement.

2. a. All repairs shall be cut so the edges are parallel or perpendicular to the traveled way.

b. Saw over-cuts shall be kept to a minimum. If saw over-cuts occur, they shall be thoroughly cleaned with compressed air to remove all dust, dirt, loose material and moisture, and sealed with hot pour joint sealant.

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c. For full depth repairs, dowel bars and/or tie bars shall be anchored into the faces of the existing concrete as designated in the plans. Full depth relief cuts approximately 4 inches (100 mm) wide may be made with a wheel cutter through the repair section if:

- the cutting operation produce minimum disturbance of the foundation course material,
- the cut does not encroachment into the concrete of the adjoining lane, or
- the cutting operation does not damage the adjacent pavment..

(1) Dowel bars or tie bars shall be anchored into the faces of the existing concrete as designated in the plans. To provide proper alignment, a drill approved by the Engineer shall be used to install the dowel bars. The drill shall be capable of drilling the holes parallel to the surface of the pavement and to the centerline of the highway ± 1/8 inch.

(i) A minimum of 2 tie bars shall be placed on each side of a full depth pavement repair as designated in the plans.
(ii) The dowel bar holes shall be drilled at the same plane ±1/8 inch and at the spacing shown in the plans, except that they shall be centered between the locations of the previous bars.
(iii) The tie bar holes can be drilled independently.
(iv) The drilled holes shall be thoroughly cleaned with compressed air to remove all dust, dirt, loose material and moisture.

(2) After cleaning and prior to dowel or tie bar insertion, an application of grout or epoxy shall be made at the back of the hole. The grout or epoxy shall be from the Approved Products List. Twist the dowel or tie bar one full turn during insertion to completely surround it with the grout or epoxy. Retention disks shall be placed on the bars as designated in the plans.

c. The corners of the repair section shall be prepared with reasonably neat vertical surfaces using a 15-pound (maximum) chipping hammer. Any exposed tie bars shall cut flush with the vertical surfaces. The initial removal of any concrete pavement other than that described above shall be removed by means of a jackhammer not exceeding 35 pounds (16 kg). The repair sections shall be removed to the lines designated by the Engineer, including reinforcement that interferes with the operations. The cut-away repair section shall be removed with minimum disturbance of the underlying foundation course. Any loosened or fouled foundation course material shall be removed and replaced with concrete.

3. The Contractor shall remove and dispose of all old pavement, reinforcing steel, and all other materials that are removed and not identified for reinstallation.

4 New tie bars shall be installed into holes drilled in the existing concrete and secured in place with an approved non-shrink grout or epoxy.

5. The Contractor shall compact the subgrade or foundation course under full depth patches to the maximum density achievable with equipment approved by the engineer. Water shall be sprinkled on the subgrade before placing the concrete.

6. Where the repair area is not bordered by existing concrete pavement, a form shall be used as the pavement edge to provide the same surface elevation and edge alignment as the existing pavement. The form shall be supported or braced in position in a manner that is approved by the project manager. Forms for concrete pavement repair shall conform to the requirements of Subsection 603.03 of the Standard Specifications, except that forms may be wood when the length of the patch is less than 13 feet (4 m).

7. The Contractor shall furnish and place the concrete. The concrete shall be handled and consolidated so there will be no separation of the aggregate and the mortar.

8. An internal vibrator shall be used to consolidate the concrete. Excessive vibration shall be avoided.

9. After the concrete is consolidated, it shall be struck off to a uniform height approximately 0.4 inch (10 mm) above the finished surface.

10. A vibrating screed shall be used on a full depth concrete repair that is 5 feet or wider to finish the concrete to the final elevation.

Attachment B

11. Immediately after finishing the concrete, it shall be floated with a magnesium bull float. The surface shall be hand tined as required by the contract. The new tining shall be parallel to the existing tining in the adjacent concrete pavement.

12. a. The Contractor shall cut joints to match the existing pavement joints. Transverse joints shall be established by sawing to a minimum of one-third the actual thickness of the slab and then creating a well as shown in the plans.

b. The pavement elevation of repair areas shall be corrected in a manner that eliminates swales or bumps. Swales and bumps are defined as having a 1/8 inch or greater deviation using an approved 10 foot straightedge. Correction shall be diamond grinding or replacement. The condition of the adjacent pavement shall be considered when evaluating the 1/8 inch deviation requirement.

13. The Contractor shall edge the surface that abuts a transverse joint to provide a well 0.4 inch (10 mm) wide and 0.6 (15 mm) inch deep.

14. The Contractor shall use an edging tool to finish all exterior edges of the new concrete.

15. a. The Contractor shall apply curing compound to all concrete pavement repairs.

(1) When pavement and joint repairs are overlaid with asphaltic concrete, the curing method shall be with tack coat, or an approved asphalt emulsion.

b. White pigmented curing compound shall be used when surfaces are exposed to view.

c. The application rate shall be 1 Gal/150 SF.

16. a. Class 47B-3500 (47B-25 MPa) concrete pavement repairs shall not be opened to traffic until the compressive strength reaches 3500 psi (25 MPa). Table 2 is a guide to the minimum time before traffic will be allowed on the new concrete.

b. Concrete shall not be placed when ambient air temperature is expected to drop below 40°F (4°C) during the cure period.

Table 2

Time Until Traffic Allowed (Class 47B-3500 24 MPa)	
Minimum Ambient Air Temperature [°F (°C)]	**Minimum Time Before Opening (Hours)**
Below 41 (5° C)	120
41 – 60 (5°-16°C)	72
Above 60 (16°C)	48

17. a. Disturbed or damaged areas in the existing surfaced shoulder resulting from the repair operation shall be repaired by the Contractor at no additional cost to the Department.

b. Damaged areas of the surfaced shoulders shall be removed by sawing.

18. The Contractor shall seal all transverse and longitudinal joints as prescribed in Section 603 of the Standard Specifications.

19. All pavement markings removed or damaged as part of the repairs shall be installed in accordance with the contract.

Method of Measurement and Basis of Payment

All work associated with making the repairs, pavement marking and traffic control shall be provided at no cost to the Department.