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CHAPTER NINE:
PORTLAND CEMENT CONCRETE PAVEMENT PATCHING

Portland cement concrete pavement patching consists of the removal and replacement of unsound concrete, either full depth or partial depth. The following items are discussed in this chapter:

1) Materials and the composition of patching concrete

2) Removal of unsound concrete

3) Preparation of the patch for placement of the new concrete

4) Placement of the patching components

5) Temperature and curing requirements

6) Method of measurement

7) Basis of payment

MATERIALS

Materials used for the Portland cement concrete patching include:

1) Dowel bars

2) Fine aggregate

3) Coarse aggregate, Class AP

4) Portland cement, Type I

5) Water

6) Calcium chloride

7) Air entraining admixture

8) Water reducing admixture

9) Liquid membrane forming curing compound

All of the materials are required to meet the requirements of Section **506**, Section **900**, and the Approved List for materials

CONCRETE MIX DESIGN

A Concrete Mix Design (CMD) in accordance with Section **506.04** is required to be submitted to the Project Engineer, prior to the placement of any concrete. The CMD shall include the following:

1) A list of all ingredients

2) The source of all materials

3) The fine to total aggregate ratio

4) The absorption of the aggregates

5) The SSD bulk specific gravity of the aggregates

6) The batch weight

7) The names of all admixtures

8) The admixture dosage rates and the manufacturer's recommended range

A change of any source of material or proportions of the aggregate require a new CMD**.** The Contractor may change the dosage rate of an admixture within the manufacturer's recommended range; however, a new CMD is required for the addition or deletion of an admixture.

CONCRETE MIX CRITERIA

The following requirements and/or properties of the concrete are required:

1) The fine aggregate is required to be at least 35%, but not more than 45%, of the total aggregate weight per cubic yard, based upon SSD aggregates.

2) A minimum portland cement content of 658 lbs/yd^3

3) A maximum water/cement ratio of 0.40

4) A slump of 2 inches to 5 inches

5) An air content of 5.0% to 8.0%

6) A minimum flexural strength, third point loading, of 300 psi at 24 hours

7) A minimum flexural strength, third point loading, of 500 psi at 3 days

8) A water reducing admixture is required

9) Calcium chloride solution is required to be added to the concrete at the maximum rate of 2% by weight of cement. The percentage is reduced to 1% if the ambient temperature is above 80° F. If the calcium chloride solution is added at the jobsite, an additional 40 revolutions of mixing time is required prior to discharge.

TRIAL BATCH DEMONSTRATION OF CMD

Once a CMD has been submitted and approved by the Project Engineer, a trial batch is conducted and the concrete is tested to verify that the CMD meets the required criteria.

The trial batch may be produced prior to construction in a laboratory, at the plant, or at the project site on the first day of placement.

The PE/PS verifies the following from the trial batch demonstration and provides all of the test results to the Contractor:

1) The material sources

2) Air content

3) Water/cement ratio

4) Flexural strength. The flexural strength is determined by averaging a minimum of two beam breaks.

The trial batch is required to be of sufficient quantity so that all of the required tests may be conducted from the same batch. Trial batch concrete is not to be used for more that one test.

When the production from the first day is used as a trial batch, production may continue until the flexural strength tests are completed. If 1 day or 3 day flexural strength tests fail, production is required to be stopped and a new CMD is developed and submitted.

ACCEPTANCE

Job control testing, including air, slump or flexural strength, is conducted by the Technician in accordance with Section **506** and the Frequency Manual. The PE/PS notifies the Contractor when the testing results are not in accordance with the Specifications. Rounding of test results is required to be in accordance with Section **109.01(a)**.

REMOVAL OF CONCRETE

PARTIAL DEPTH PATCHES

Partial depth patches are required to be a minimum of 1 in. and a maximum of 3 in. deep. The area to be patched is determined and marked by the PE/PS. Some areas to be patched are obvious upon visual examination, such as spalled concrete, pot-holes, and/or areas with hair line "spider-web" cracking. Other areas may not be obvious on the surface and may only be identified by "sounding" the concrete. Sounding concrete is done in a variety of ways, such as dragging a short section of heavy chain across the surface of the concrete, tapping the surface with a hammer, or bouncing a section of rebar on the surface. Good, sound concrete will have a "ring" or "tinny" sound when tested, and unsound concrete will "thud" or sound "dead" when tested. Sounding may also be used to determine the extent of removal at the locations where patching is visually identified. Special care is required to be taken to investigate the areas adjacent to joints for possible failures.

The perimeter of the patches is first sawed a minimum of 1 in. in depth. Transverse saw cuts are made perpendicular to the centerline of pavement. If the saw cut is damaged during removal, a parallel cut is made 1 in. outside the initial cut and the patch extended to this line. Hand held jack hammers are used to remove the unsound concrete. The hammers are operated at a maximum angle of 45 degrees to the surface of the pavement. This procedure prevents undue stress and/or damage to the good, underlying concrete and facilitates the removal of the unsound concrete on the surface.

If wire mesh is encountered during the removal process, the exposed portion of the mesh is required to be removed. If reinforcing steel is encountered, the patch is required to be a full depth patch in accordance with Section **506.07(b)**. If unsound concrete is found to exist below the 3 inch level, the patch also is required to be a full depth patch. Generally, partial depth patches are sounded after the initial removal operation to assure that all unsound concrete has been removed.

FULL DEPTH PATCHES

Full depth patches are first saw cut through the entire depth of the pavement for the full width of the lane. This procedure is done to separate the unsound concrete in the patching area from the adjacent sound concrete so that good pavement is not damaged during the removal process. Machine mounted removal equipment, such as pavement breakers or hoe rams, may be used to remove the concrete in the patch area as long as the removal process does not damage the adjacent sound concrete.

Full depth patches are required to be a minimum of 6 ft in length. If the removal areas in the same lane are closer than 10 ft, the limits of the patches are extended to also remove this area of concrete. If a transverse joint is in the removal area, the limits of removal are required to be at least 1 ft beyond the joint. Full depth removal continues until sound concrete, sufficient to anchor dowel bars, is present. The bottom of the full depth patch is required to be located at the bottom of the existing PCCP subbase or 6 in. below the bottom of the existing pavement, whichever is lower. All subbase that has been disturbed during the removal process is required to be compacted.

PLACEMENT OF PATCHING MATERIALS

PARTIAL DEPTH PATCHES

Partial depth patches are thoroughly sandblasted just prior to placing new concrete and cleaned of all dust, chips, and water. The dust and debris in the patching area is blown with a compressed air jet. Air lines for the sand blaster and air jet are required to be equipped with oil traps to prevent oil residue in the patch area. Just prior to placing new concrete in the patch, the hole is coated with an approved epoxy adhesive. Care is taken to insure that the adhesive does not become contaminated with dust and/or dirt. If contamination occurs, the patch is required to be cleaned and recoated with adhesive prior to concrete placement. The adhesive manufacturer's recommendations for the length of time allowed between the time that a patch is coated and the time that concrete may be placed is required to be reviewed. If this time is exceeded, the patch is required to

be re-cleaned and recoated with fresh adhesive. Existing joints, which occur within the patch limits, are continued to the surface by means of preformed joint filler or forms. Partial depth patching is avoided at D-1 contraction joints, if at all possible. Generally, D-1 joints are patched with full depth patching. Concrete is required to be placed, vibrated for consolidation, and hand finished in accordance with Section **504**. Once the patch has cured, the joints are sawed and sealed in accordance with Section **503**.

FULL DEPTH PATCHES

Full depth patches are required to have dowel bars installed in the adjoining pavement in accordance with Standard Drawing **E506-CCPP-01**. The dowel bars are to be sized as follows:

DOWEL BAR SIZES

Pavement Thickness	Minimum Dowel Bar Diameter
Less than 9 in.	1 in.
9 in. through 12 in.	1-1/4 in.
Greater than 12 in.	1-1/2 in.

Holes are drilled in the existing pavement to accept the dowel bars. Care is taken when drilling the holes so that they are parallel with the edge and surface of the pavement. The dowel bars are coated with an approved chemical anchoring system, the holes are filled with this same material, and the dowel bars are inserted into the holes. When inserting the dowels in the holes, the dowels are given a twisting motion to insure that all the voids between the dowels and the hole are filled with the anchoring material. The proper alignment of the dowel bars is required to be maintained until the anchoring material hardens. Joints, which occur in the adjacent pavement, are required to be continued through the patch area. Patches longer than 18 ft are required to have D-1 contraction joints in accordance with Section **503.03(a)**. Concrete is placed, consolidated by vibration, and hand finished in accordance with Section **504**. Texturing and tining are not required if the pavement is to be re-surfaced. Sawing and sealing of the transverse joints is required to be in accordance to Section **503**.

If the PCCP is to be resurfaced, the sawing and sealing operation may be omitted. Concrete for full depth patches may only be placed after 1:00 p.m. if the next day's forecasted ambient temperature is 70° F or greater, unless otherwise directed. This time limitation allows the existing pavement to fully expand before placing the concrete and reduces the risk of damage the expansion may cause to the curing patch.

CURING

Partial depth and full depth patches are cured in an identical manner. A liquid curing compound is applied to the surface of the patch as soon as practicable after placement. The patch is then covered with a sheet of polyethylene film and a 4 in. layer of rigid or flexible insulation. The film and insulation are firmly anchored using small dimension lumber and/or sandbags. Large, heavy objects, such as pieces of rip rap, concrete blocks, etc., are not to be used as they could pose a hazard to the motorist.

If a patch has been constructed and cured in accordance with the Specifications, the pavement may be opened to traffic according to the following table.

T	H	HT
40-42 º F	30	26
43-45 º F	27	23
46-48 º F	24	21
49-51 º F	21	19
52-54 º F	19	16
55-57 º F	16	14
58-60 º F	16	11
61-63 º F	14	9
64-66 º F	14	9
67-69 º F	14	8
70-72 º F	14	7
73-75 º F	14	6
Above 75 º F	14	5

where:

T = lowest ambient temperature during placement, or the temperature of concrete at time of delivery, whichever is lower

H = time in hours to open to traffic

HT = time in hours to open to traffic when the average daily traffic is less than 10,000

A patch may be opened to traffic sooner than allowed by the preceding table if test beams indicate a flexural strength of at least 300 psi.

METHOD OF MEASUREMENT

Partial depth and full depth patching are measured by the square yard. The concrete removal, subbase and subgrade excavation, subbase and subgrade re-compaction, epoxy adhesive, dowel bar chemical anchoring system, concrete finishing and curing, and sawing and sealing of joints are not measured for payment.

BASIS OF PAYMENT

PCCP patching is paid for at the contract unit price per square yard for the type of patching required.

Partial depth patches, which have been directed to be made full depth, are paid for at the contract unit price per square yard for partial depth patching, plus 80 % of the contract unit price per square yard for full depth patching.

The cost of concrete removal, patching, and all necessary incidentals is included in the cost of concrete pavement patching.