

SPECIFICATION 501 – PORTLAND CEMENT CONCRETE PAVEMENT

501-1 DESCRIPTION

501-1.01 Scope - This work shall consist of the construction of Portland cement concrete pavement, constructed in accordance with these specifications, the standard drawings (PCCP) and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. This work also consists, when called for in the plans, of widening of existing pavement.

501-2 MATERIALS

501-2.01 The following materials shall meet the applicable requirements of the following specifications:

| <u>Material</u> | <u>Specification</u> |
|-------------------------------------|----------------------|
| Portland Cement..... | 701-1 |
| Reinforcing Steel..... | 709-1 |
| Epoxy Coated Reinforcing Steel..... | 709-3 |
| Curing Materials..... | 711-1 |
| Air-entraining Admixtures..... | 711-2 |
| Chemical Admixtures..... | 711-3 |
| Water..... | 712-1 |
| Geotextiles..... | 712-7 |

501-2.02 Fine Aggregate - Shall conform to the requirements of Article 703-1 of Specification 703 - Aggregates, except that the use of manufactured sand shall not be permitted.

501-2.03 Coarse Aggregate - Shall conform to the requirements of Article 703-2 of Specification 703 - Aggregates but provided that:

- a. The grading shall be of the designated size 2” to 1” shown in Table 703-2; however, the grading distribution shown in this table is only suggested and not mandatory

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provided the limiting maximum and minimum size values are complied with.

- b. The aggregate shall have a minimum polishing value of 48% as determined by ASTM D 3319.

501-2.04 Dowels and Tie Bars - Dowels for all transverse and construction joints shall be made of epoxy coated reinforcing steel of the types and sizes shown in the standard drawings. Tie bars for longitudinal joints shall be made of epoxy coated reinforcing steel of the types and sizes shown in the standard drawings.

501-2.05 Silicone Joint Sealers – Only the silicone joint sealers products included in the Authority's approved list, incorporated in the standard drawings, shall be used for the respective approved usage and installed following the manufacturer's recommendations. Backer rod material shall be of the size indicated in the standard drawings and shall meet the requirements specified in Article 507-2.02 of Specification 507.

501-2.06 Pavement Drains

- a. Plastic PVC or corrugated polyethylene pipe for the pavement drains shall be of the size, class and types specified in the standard drawings and shall conform to the applicable requirements of Sections 706-4 and 706-5 of Specification 706 - Concrete and Plastic Pipe.
- b. Granular filter material shall be a Filter Material Type B as per Specification 718 - Stone Revetment Materials and as per the standard drawings.
- c. Plain concrete for drain outlets shall be Class "B" conforming to the requirements of Specification 601 - Structural Concrete.

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501-2.07 Proportioning of Concrete

a. The Contractor shall design the concrete mix determining the proportions of Portland cement, coarse and fine aggregate, and water necessary to produce a workable concrete meeting the following requirements:

1. A compressive strength of 5,000 psi at 28 days.
2. A maximum slump of 3 inches for fixed form paving and 2 1/2 inches for slip form paving.
3. If air-entrained concrete is used, the mix shall contain not more than 6 percent entrained air as determined by AASHTO T 152.

b. The Contractor shall design the mix on the basis of an absolute volume method such as outlined in the American Concrete Institute (ACI) Standard 211.1, "Recommended Practice for Selecting Proportions for Normal Weight Concrete", or Bulletin No. 11, "A Method of Proportioning Concrete for Strength, Workability, and Durability", published by the National Crushed Stone Association.

c. Water reducing, set retarding or superplasticizer chemical admixtures may be used at the option of the Contractor but subject to approval by the Engineer. The Contractor shall indicate in advance the particular type and name product of admixtures that he proposes to use and only such admixtures approved by the Engineer may be incorporated into the concrete mix. Admixtures selected for use shall be compatible with all other components of the concrete. The use of calcium chloride as an admixture will not be permitted.

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d. The Contractor shall submit for the record, not later than 15 days prior to the start of paving operations, the proposed mix design including the aggregates grading to be used. The submission shall be accompanied with certified laboratory reports on the tests performed on the trial mixes. In the event that the concrete mix designed by the Contractor does not produce concrete of the specified strength and workability, the Contractor shall adjust the mix as required to meet the specified requirements at no additional cost to the Authority and shall submit new certified test results.

e. In the event the Contractor elects to use an air-entraining admixture, he shall determine by trials the amount of the selected admixture that will produce concrete having the desired air content and the amount shall not be varied except as approved by the Engineer. The admixture shall be added during batching at the plant in accordance with the admixture manufacturer's recommendations.

f. The Contractor shall determine the proportions and batch weights for air-entrained concrete in the same manner as for regular concrete provided, however, that in making such adjustments as may be necessary by reason of air-entrainment, the minimum quantity of fine aggregate and the minimum quantity of water shall be used which will provide concrete of the required workability.

g. Whenever the Contractor modifies the concrete mix, other than minor adjustments in the relative quantities of fine and coarse aggregates, he shall submit copy of the new mix design, together with certified copies of tests results, to the Engineer.

h. No change in the sources or character of the materials shall be made without due notice to the Engineer. No new

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materials shall be used until approved by the Engineer and until new trial mixes have been designed, tested and accepted.

501-2.08 Sampling and Testing

a. Compliance with the specification requirements included in the above articles will be determined in accordance with the following AASHTO standard tests:

| | |
|--|-------|
| Sampling Fresh Concrete | T 141 |
| Sieve Analysis of Aggregates | T 27 |
| Consistency (Slump) | T 119 |
| Weight per Cu. Ft. and Air Content | T 121 |
| Air Content of Freshly Mixed Concrete (Pressure Method) .. | T 152 |
| Air Content of Freshly Mixed Concrete (Volumetric Method)..... | T 196 |
| Making and Curing of Test Specimens | T 23 |
| Compressive Strength of Cylindrical Concrete Specimens ... | T 22 |

b. Sampling frequency for compressive strength testing shall be one set of six (6) specimens for each 125 square meters of concrete pavement or fraction thereof placed each day for testing at 7 and 28 days. All concrete cylinders will be taken by the Authority.

c. Additional cylinder sets will be made as needed to determine when a pavement may be put into service.

d. The Contractor shall furnish at his expense all metal molds or single use plastic molds with lids, conforming to AASHTO M 205 and T 23, that are necessary to comply with the required frequency of sampling. As a subsidiary obligation, when using single use plastic molds, the

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Contractor shall furnish stripping tools for removing the sample from the mold. Cardboard molds will not be accepted.

e. Slump tests will be made by the Authority of the concrete from each batch from which test cylinders are taken. Additional slump tests will be made as determined by the Engineer to check the consistency of the concrete.

f. Samples will be taken at random by the Authority of the fresh mix delivered to the project from which the cement mortar will be washed out and the remaining aggregates recovered for testing for compliance with the requirements of Articles 501-2.02 and 2.03 of this specification as to source, wear and polishing values.

g. Concrete for test specimens will not be included in the measurement for payment but shall be furnished by the Contractor without additional compensation.

501-2.09 Basis of Acceptance

a. In general, the acceptability of the quality of the concrete pavement will be based on slump tests, air content tests, aggregate tests, and on the results of standard compressive strength tests of representative samples at 28 days as covered by these specifications. However, this does not relieve the Contractor of the responsibility for the concrete during placement, consolidation, finishing, curing or protection prior to final acceptance by the Highway Authority.

b. Concrete shall be placed at a slump as nearly consistent with the design mix value as is practical. Any batches with slumps varying from the design mix specified values by more than tolerance shown below will be rejected for use in the work.

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| <u>Specified Slump</u> | <u>Tolerance</u> |
|------------------------------|------------------|
| 2 in. or less..... | + 1/2 in. |
| More than 2 in. to 4 in..... | + 1 in. |
| Greater than 4 in..... | + 1 1/2 in. |

c. Air content, when specified, shall be within $\pm 2\%$ of the design value. Any batches with air content exceeding this tolerance will be rejected for use in the work.

d. Concrete pavement found to contain aggregates which fail to meet the polishing value requirements shall be replaced or corrected as directed by the Engineer at no cost to the Authority.

e. The 28-day compressive strength of the quantity of concrete placed and represented by one set of cylinders shall be determined as the average of the three cylinders comprising the set. If any cylinder shows evidence of improper sampling, molding, handling, curing or testing, the test result of such defective cylinder shall be discarded and the compressive strength of the concrete represented shall be determined from the test results of the remaining cylinders. Low strength shall not be a basis for discarding a cylinder test result.

f. The compressive strength level of the concrete pavement will be considered satisfactory if both of the following requirements are met:

1. The average of all sets of six consecutive tests (moving average) equals or exceeds the specified compressive strength of 5,000 psi.

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2. No individual test (average of cylinders set) falls below the specified compressive strength by more than 500 psi.
- g. Should concrete used in the work fail to conform to the requirements in paragraph “f” above, the Contractor shall, at his expense, make corrective changes, subject to the approval of the Engineer, in the material mix proportions or in the concrete fabrication procedures, before placing additional concrete. In addition, such corrective changes shall be made when the strength of concrete tested at 7 days shall consistently indicate that the concrete will not attain the specified compressive strength of 5,000 psi at 28 days.
- h. When the moving average fails to meet the compressive strength requirement, the in-place concrete pavement will be considered deficient but will be accepted if the deficiency in the moving average does not exceed 500 psi and if no individual cylinders set is deficient by more than 500 psi, but payment for the concrete represented by the failing averages will be paid for at a reduced unit price as specified in Article 501-5.01.
- i. All concrete pavement represented by cylinders set which indicates a compressive strength falling below the specified value by more than 500 psi will be considered deficient and will be rejected. Such rejection may be reconsidered under the conditions specified in paragraph “j” below when requested by the Contractor.
- j. The Contractor may elect to drill core samples of the hardened deficient concrete, at his expense but under the direction and supervision of the Engineer, to be tested at the Authority’s laboratory. The following criteria shall govern the coring program:

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1. The obtaining and testing of drilled cores shall be in accordance with AASHTO T 24 and T 22. Moisture conditioning shall be in accordance with paragraph 6.3 of T 24.
2. Three cores shall be taken for each 125 square meters, or fraction thereof, of concrete pavement classified as deficient as result of the cylinder tests, at random locations selected by the Engineer.
3. The cores shall be drilled no earlier than 28 days and no later than 56 days after the pouring of the concrete in question. Failure of the Contractor to extract the cores within the specified time limits, will void the Contractor's right to retesting. At its discretion the Authority may waive the specified time limits.
4. The core compressive strength shall be the average of all cores tested. The concrete pavement in the area represented by the core tests will be considered acceptable as to strength if the average of all the cores is at least 4,250 psi and if no single core test value is less than 3,750 psi.
5. Should the first set of cores show deficient strength, the Contractor will have the option, at his expense, of obtaining one additional set of cores for further testing. This additional cores shall be drilled no later than 56 days after the pouring of the concrete in question, shall not exceed the number of drilled for the first set and shall be subject to the criteria in paragraphs (1), (3) and (4) above. However, the results of all cores tested will be used in determining the average strength. All cores must be extracted within the specified time limits.

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6. The Contractor shall backfill the core holes with concrete at his expense.
- k. Concrete pavement that fails both the cylinder and core strength test acceptance criteria will be rejected and shall be removed and disposed of at the Contractor's expense.
- l. Test values of cylinders and cores representing rejected concrete pavement which is to be removed will be eliminated from the average strength computations specified in paragraphs "f", "h", and "k" above.
- m. When the cylinder tests results indicate that the concrete mix meets the specification strength requirements but the Authority has reasonable doubts as to the actual strength of the in-place concrete due to deficiencies in the placing, consolidation, curing or protection of the concrete pavement, the Authority may order the Contractor to have cores drilled and tested following the procedures specified in paragraph "j" above. If these cores meet the acceptance criteria specified in paragraph "j" above, the Authority will bear the cost of the drilling, testing and repair. However, if the cores fail, the Contractor shall bear the costs, and the deficient concrete pavement may be subject to rejection and removal.
- n. The Contractor will be held responsible for any cracking of the concrete pavement and will be the Contractor's responsibility to repair or remove and replace the affected pavements at no cost to the Authority.

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501-3 CONSTRUCTION REQUIREMENTS

501-3.01 General

- a. The Portland cement concrete for the pavement may be produced at the project site or may be supplied by a commercial plant as ready-mixed concrete conforming to the requirements of AASHTO M 157 as modified and supplemented by this specification.
- b. In all Portland cement concrete production, the Contractor shall be responsible for the quality control of all materials during the handling, batching, mixing, placement, curing and protection operations.
- c. All equipment and tools necessary for handling materials and performing all parts of the work shall be in good working condition, checked for conformance with the requirements of the specifications and approved by the Engineer as to design, capacity, and mechanical condition.
- d. The Contractor may perform the paving operations either by the fixed form method or the slip form method, at his option, unless otherwise specified in the contract documents. However, the Contractor shall advise the Engineer as to the method he proposes to use at least 60 days in advance of the proposed start of paving operations.

501-3.02 Batching, Mixing and Delivery

- a. Batching, mixing and delivery equipment and operations shall conform to the requirements of Article 601-3.02 and 601-3.03 of Specification 601 - Structural Concrete.
- b. No concrete shall be mixed, delivered, placed or finished when the natural light is insufficient to properly

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perform and control the paving operations unless an adequate and approved artificial lighting system is provided.

501-3.03 Consistency - All concrete delivered for the pavement shall show a slump of plus or minus 1/2" of the slump specified in the approved design mix. Concrete within the permissible slump range shall be available throughout the complete period of discharge except for the first and last 1/4 cubic yard discharged.

501-3.04 Paving Equipment

a. Paving equipment shall be at the job site sufficiently ahead of the start of paving operations to be thoroughly examined and approved, if satisfactory, by the Engineer.

b. When the fixed form method is used to construct the pavement, the required equipment includes:

1. Forms - Straight side forms shall be made of metal having a thickness of not less than 0.56 centimeters (7/32 inch) and shall be furnished in sections not less than 3 meters in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to or greater than the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 30-meter radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer.

Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the spreading, consolidating and finishing equipment. Flange braces shall extend

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outward on the base not less than $\frac{2}{3}$ the height of the form.

Forms with battered top surfaces, and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved by the Engineer. Built-up forms shall not be used except where the total area of pavement of any specified thickness on the project is less than 1,500 square meters. The top face of the form shall not vary from a true plane more than 3 mm. in 3 meters. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and for secure setting.

2. Spreading and Finishing Machines - Shall be self-powered and shall be capable of spreading, consolidating and finishing the freshly placed concrete to the required pavement elevation and cross-section within the specified tolerances. In addition:

(a) The finishing machine shall be equipped with at least two oscillating type transverse screeds, and a pan float shall be attached to the finishing equipment behind the last screed.

(b) Vibrators shall be provided for full width vibration of the concrete pavement slabs. These vibrators may be either of the surface pan type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joints, load transfer devices,

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subgrade or side forms. The frequency of surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal vibrators shall be not less than 5,000 impulses per minute for tube vibrators, and not less than 7,000 impulses per minute for spud vibrators. The Contractor shall have available at the job site a copy of the manufacturer's literature on the vibrators, showing that they comply with the above requirements. Vibrators will not be permitted to operate when the spreaders or finishing machines are stopped.

(c) When the spreading and/or finishing machines are operated on an adjacent pavement, the equipment shall be provided with approved rubber tired, flangeless wheels to avoid damage to the adjacent lane.

c. For slip form paving, the paver shall be self-propelled and shall be capable of spreading, consolidating, screeding and float-finishing the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the plans and specifications.

1. The paver shall be equipped with electronic controls and sensing devices to control line and grade.
2. Sliding forms on the paver shall be rigidly held together laterally to prevent spreading of the forms.

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3. Hand floats, 3 meters long, designed to eliminate small surface irregularities may be utilized in the finishing operation.

4. Vibrators as required in paragraph B(2)(b) above shall be provided.

d. Concrete Saws - The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions indicated in the Standard Drawings and at the required rate. The Contractor shall provide at least one stand-by saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

501-3.05 Preparation of Grade

After the subgrade and base course have been placed and compacted, the areas which will support the forms and the paving machines shall be trimmed to the proper elevation, extending the work on each side at least 30 centimeters beyond the outside edge of either (1) the fixed forms or (2) the slip form paving equipment trackline or wheelpath.

501-3.06 Setting Forms

a. Base support - The foundation under the forms shall be hard and true to grade so that each form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with base material for a distance of 30 centimeters on each side of the base of

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the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected as necessary.

b. Form setting - Forms shall be set at least 150 meters in advance of the point where concrete is being placed. Forms shall be staked into place with not less than 3 pins for each 3-meter section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 5 mm. at any point. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the paving equipment. Forms shall be cleaned and coated with a form release agent or oiled prior to the placing of concrete.

c. Grade and alignment - The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the area shall be corrected and the form shall be reset and rechecked.

501-3.07 Conditioning Base Course

a. When the forms have been securely set to grade, the base course shall be tested for conformity with the crown and elevations shown on the plans by means of an approved toothed template riding on the side forms. High areas shall be trimmed to proper elevation. Low areas may be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

b. When the concrete pavement is placed on a bituminous mix base course, care shall be exercised to insure

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that the required keyways indicated on the standard plans have been left in the base course. Providing these keyways is a subsidiary obligation of the Contractor under the pavement pay items.

c. When an untreated aggregate base course is specified, the base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the base course shall be sprinkled, but the method of sprinkling shall be such as to not form mud or pools of water. During concrete paving operations, the Contractor shall maintain in readiness a roller weighing not less than 5 tons for use in recompacting the base course in case that, for any reason, it becomes defective or uneven. Soft spots in the base course shall be corrected to meet the requirements of the applicable base course specification prior to placing concrete.

d. Traffic will not be allowed on the finished base unless specifically permitted by the Engineer.

501-3.08 Placing Concrete

a. The concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such manner as to prevent segregation of the materials. Placing to the full depth and width shall be continuous between transverse joints without the use of intermediate bulkheads except when a disruption in the paving operation occurs. A transverse construction joint meeting the requirements of paragraph 501-3.11d shall be formed whenever concrete paving operations are stopped longer than 30 minutes. If, due to any disruption, concreting must be stopped within 3 meters after forming a transverse joint, the Contractor shall remove the concrete to the joint previously formed and no payment will be made for placing or removing this concrete.

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- b. The concrete shall be placed in such a manner as to provide a dense and homogeneous pavement with a minimum of hand finishing. The equipment shall have as nearly a continuous forward movement as possible and all operations of delivery and spreading of the concrete shall be so coordinated as to provide a uniform progress with stopping and starting the placing equipment held to a minimum. If, for any reason, it is necessary to stop the forward movement of the equipment, the vibratory and tamping elements shall also be stopped immediately.
- c. Hand spreading, when necessary, shall be done with shovels, not rakes. Workmen shall not be permitted to walk on the fresh concrete with boots or shoes coated with earth or other deleterious substances.
- d. Where concrete is to be placed adjoining a previously constructed lane of concrete pavement and mechanical equipment will be operated upon the existing lane of pavement, no paving shall be performed until at least 14 days have elapsed since the existing lane was placed.
- e. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 10 seconds in any one location.
- f. Concrete shall be deposited as near to contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket, hopper, or chutes from truck mixers or truck agitators onto a joint assembly unless the hopper is well centered on the joint assembly.

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g. Should any concrete materials fall on or be worked into the surface of a completed slab, it shall be removed immediately by approved methods.

h. In order that the concrete may be properly protected against the adverse effect of rain before it has hardened sufficiently, the Contractor shall have available at all times covering material for the protection of the surface of the unhardened concrete. Such protective materials shall consist of burlap or other material suitable for the purpose. When rain appears imminent, all concrete paving operations shall stop and the Contractor shall cover the surface of the unhardened concrete with the protective material.

i. Concrete shall be protected from the adverse effects of high concrete temperature, high air temperature, high wind speeds, low humidity, or a combination thereof, by following the protective requirements included in Article 601-3.08 of Specification 601 - Structural Concrete but adding the following under paragraph 601-3.08c:

1. Giving a whitewash of water and lime to the bituminous base course when a Portland cement concrete pavement is to be laid over such a base.

501-3.09 Strike-off of Concrete and Placement of Reinforcement

a. Following the placing of the concrete, it shall be struck-off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans.

b. When reinforced concrete pavement is specified, the reinforcement shall be positioned and supported on chains in

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advance of concrete placement. The reinforcing steel shall be free from dirt, oil, paint, grease, mill, scale, and loose or thick rust which could impair the bond of the steel with the concrete.

501-3.10 Slip Form Paving - If the Contractor is required to or elects to use the slip form method of paving, the following applies to the placing, strike-off and initial finishing of the concrete.

- a. The completed base course shall extend ahead at least 300 meters prior to beginning paving operations. The surface over which the tracks of the slip form paver will travel shall not vary more than ± 0.5 centimeters from the established grade.
- b. Concrete for slip form paving shall be produced at a uniform consistency with a slump not exceeding $2\frac{1}{2} \pm \frac{1}{2}$ inches.
- c. The paving machine shall be equipped to vibrate the concrete for the full width and depth of the pavement being placed. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur, and that necessary strike-off and finishing can be accomplished while the concrete is still within the forms. If the edges of the completed pavement tend to slump, the Contractor will be required to use a lower slump as necessary to prevent this condition.
- d. The slip-form paver shall be operated with a continuous forward movement and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and

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tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

e. Steel tie bars shall not be inserted into the unsupported side of the freshly formed concrete slab. Bars shall be placed by a method, subject to approval by the Engineer, that shall result in the placement of the tie bars at the specified locations with no damage or disruption to the concrete.

f. Strike-off and placing of reinforcement shall be as provided in Article 501-3.09 above.

501-3.11 Joints

a. Joints shall be constructed of the type, dimensions and other details shown standard drawings or as indicated on the plans. All joints, except construction joints, shall be sawed and shall be protected from the intrusion of injurious foreign material until sealed.

b. Longitudinal Joints

1. Deformed, epoxy coated, steel tie bars of the length, size and spacing specified on the standard drawings or the plans shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement.

2. Tie bars shall not be painted or coated with any material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, side forms shall be used which will form a keyway along the construction joint. Tie bars may be bent at

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right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed. In lieu of bent tie bars, approved two-piece epoxy coated connectors may be used.

3. Longitudinal joints shall be sawed to the depth, width and line shown on the standard drawings or as shown on the plans. Suitable guidelines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the plans. The longitudinal joint shall be sawed before the end of the curing period but not later than three (3) days after the pavement has been placed. All joints shall be sawed before equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

c. Transverse Contraction Joints

1. Transverse contraction joints shall consist of planes of weakness created by sawing grooves in the surface of the concrete pavement of the dimensions and at the locations and spacing shown on the standard plans.

2. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive ravelling, usually 4 to 8 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. The sawing operations shall be carried on, both during the day and night, and regardless of weather conditions, until the sawing is completed within the prescribed time lapse. The sawing of any joint shall be omitted if a crack

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occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw and the crack shall be refaced and sealed in accordance with the requirements of Specification 507 - Joint and Crack Sealing in Portland Cement Concrete Pavement, at the Contractor's expense.

3 In general, all joints should be sawed in sequence. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs.

4. After each joint is sawed, the cut and the adjacent concrete surface shall be thoroughly cleaned.

d. Transverse Construction Joints - Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 3 meters of a contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 3 meters long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

e. Load Transfer Dowels

1. Load transfer dowels shall be installed at all transverse construction joints and, unless otherwise shown on the plans, at transverse contraction joints.

2. Load transfer dowels shall be held securely in position parallel to the surface and centerline of the slab by an approved metal device that is left in the pavement or they may be implanted in the fresh

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concrete by a mechanical device provided the placing tolerances are met.

3. Load transfer dowels shall be epoxy coated, plain steel bars of the type, length, size and spacing specified on the standard drawings. One half of each of these dowels shall be thoroughly coated with heavy oil to prevent concrete from binding to that portion of the dowel or they shall be provided with a close fitting metal sleeve conforming to Article 709-1.04 of Specification 709.

f. Joints with Existing Pavements - Where a new concrete pavement abuts an existing P.C. concrete pavement, as in widening projects, deformed, epoxy coated, steel tie bars of the length, size and spacing specified on the standard drawings shall be installed at the joints between the new and the existing pavements. These tie bars shall be installed in accordance with the requirements of Article 503-3-07 of Specification 503 - Removal and Replacement of Portland Cement Concrete Pavement, Full Depth.

g. Special Joints - Special joints shall be constructed as shown on the plans, or as ordered by the Engineer, around drainage, utility and other structures located within the concrete pavement boundaries.

501-3.12 Surface Finishing and Texturing - The concrete shall be screeded and finished in accordance with these specifications. All equipment operators shall be qualified and the concrete finishers shall be competent.

a. Mechanical Finishing

1. Pavement finishing equipment shall maintain a uniform height of concrete ahead of the main

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transverse screed and along its entire length. The number of transverse screeds shall be the number required to produce the specified smoothness, but not less than two for a paving method using side forms. No backing up of any transverse screeding equipment will be permitted. The finishing equipment shall have as nearly a continuous forward movement as possible to provide uniform progress with stopping and starting of the finishing equipment held to a minimum.

2. When paving equipment utilizing tracks for mobility are used, the area on the prepared base course in the trackline shall be kept free from concrete or other debris that would affect the finished pavement surface. When fixed form paving is used, the tops of the forms shall be kept clean by a device attached to the machines and the travel of the machines on the forms shall be maintained true without lift, wobble, or other variations tending to affect the screeding operation.

3. Any edge slump of the pavement, resulting from slipform paving operations, exclusive of edge rounding, in excess of 1/4 inch shall be corrected before the concrete has hardened.

4. In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. Where application of water to the surface is permitted by the Engineer, it shall be applied as a fog spray by means of approved spray equipment.

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b. Hand Finishing

1. After the mechanical finishing operations have been completed for either slipform or fixed form paving, hand-operated smoothing lutes approved by the Engineer shall, if needed, be used to smooth out irregularities in the surface. The cutting edge of the lute shall be kept parallel to the centerline of the pavement at all times as it is moved transversely over the surface of the concrete. Excess thin mortar accumulated ahead of the lutes shall be removed from the surface of the pavement and shall not be used in filling the depressions.

2. All hand finishing of joints and surface irregularities, when necessary, shall be performed from a bridge which shall not rest on any part of the unhardened concrete.

3. Except on irregular or small areas, or in the case of breakdown of the finishing machine, hand screeding and finishing of the pavement will not be permitted. When hand finishing is used, the surface shall be struck off by means of a manual operated transverse screed. The screed shall be moved forward with a longitudinal and crosswise movement. After the above screeding has been completed, approved hand operated smoothing lutes shall be used.

c. Surface Testing and Correcting

1. After the screeding and floating has been completed but before the initial set of the concrete occurs, the pavement surface shall be tested with a 3-meter straightedge laid in contact with the surface in

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successive positions parallel to and transverse to the centerline of the pavement.

2. Any depressions found which are in excess of 0.3 mm. in 3 meters shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and across sections.

3. For this testing, the Contractor shall provide a 3-meter aluminum straightedge swung from light aluminum handles at least one meter longer than 1/2 the width of the slab.

d. Edging at Forms and Joints

1. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of the slab, and on each side of transverse construction joints and emergency construction joints shall be worked with an approved tool and rounded to a 1/4 inch radius. A well-defined and continuous radius shall be produced and a smooth dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

2. As part of the edging operation on fixed form pavements, a trowel shall be inserted between the form and the concrete for a depth of approximately

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7.6 cm. (3") along the entire length of the slab before the edging tool is used.

3. All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

e. Texturing

1. Following the surface testing and correction, and after all excess moisture has disappeared, but before the application of curing compound, the concrete pavement surface shall be given a grooved texture with a set of spring steel tines. The grooves shall be perpendicular to the centerline of the pavement unless otherwise shown on the plans. Down pressure on the pavement surface shall be maintained at all times during texturing so as to obtain uniform texturing.

2. The spring steel tines of the grooving device shall be rectangular in cross section, approximately 0.32 cm. (1/8") wide and placed on 1.9 cm. (3/4") centers. The tines shall be of sufficient length, thickness and resilience to form grooves not less than 0.48 cm. (3/16") deep in the fresh concrete surface in one pass. Final texture shall be uniform in appearance with substantially all grooves having a depth of 0.48 cm. (3/16").

3. More than one pass over the same area will not be permitted unless the surface has first been refinished. The capability of the tines to provide an acceptable texture shall be demonstrated to the Engineer prior to approval for use.

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4. The tine head may be operated by hand or mechanically. In either case, concrete texturing shall take place with the longitudinal axis of the tines as nearly at an angle of 45° to the concrete surface as is practicable to eliminate the dragging of mortar by the tines. The tines shall be kept free of hardened concrete particles.

5. On 7.30 meter wide pavements, the texturing shall be accomplished by a single continuous pass of the steel tines over the full width of the pavement.

501-3.13 Surface Test

a. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with an approved 3-meter straightedge furnished by the Contractor. All testing will be done longitudinally and transversely for the full length of each traffic lane.

b. All areas showing high spots of more than 3 mm. in 3 meters shall be marked and immediately ground, at the Contractor's expense, to within the 3 mm. tolerance in accordance with the requirements of Specification 506 - Grinding Portland Cement Concrete Pavement.

c. Areas showing low spots in excess of 7 mm. in 3 meters shall be removed and replaced, at the Contractor's expense in accordance with the requirements of Specification 503 - Removal and Replacement of Portland Cement Concrete Pavement, Full Depth. Any area so removed shall be not less than 2 meters in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 1.5 meters in length shall also be removed and replaced. The Engineer may, at his

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discretion, authorize the correction of low spots by partial depth patching in accordance with Specification 504, at the Contractor's expense in lieu of full depth replacement.

501-3.14 Curing - Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period. The Contractor will be held responsible for any cracking of the concrete pavement and will be the Contractor's responsibility to repair or remove and replace the affected pavements at no cost to the Authority.

a. Burlap mats method - The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighted down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for at least 72 hours after the concrete has been placed unless otherwise specified.

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b. Impervious membrane method

1. The entire surface of the pavement shall be sprayed uniformly with white pigment curing compound immediately after the finishing and texturing of the surface or, if the pavement is cured initially with burlap mats, it may be applied upon removal of the mats. The curing compound shall not be applied during rainfall.

2. Curing compound shall be applied by self-propelled mechanical sprayers to the top surface of the pavement under pressure at a rate of not more than one gallon per 15 square meters of area. The spraying equipment shall be of the fully atomizing type, equipped with tank agitator and with a wind guard.

3. At the time of use, the curing compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and vertical exposed concrete surfaces will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed.

4. Should the curing compound film become damaged from any cause within the required curing period of 72 hours, the damaged portions shall be repaired immediately with additional compound.

5. The Contractor shall provide on the project a sufficient quantity of approved coverings for protection of the pavement in case of rain, or when there is breakdown of the spray equipment and no

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other mechanical sprayers are available. In the event rain damages the curing compound film before it hardens, the Contractor shall apply, after the surface water leaves the pavement, a new coat to the affected areas at the maximum coverage rate of 15 square meters per gallon.

6. Upon removal of the forms, the exposed sides of the slabs shall be protected immediately to provide a curing treatment equal to that provided for the top surface. On slip-form paving, the curing compound shall be applied to the sides of the slab at the time the top surface is treated.

501-3.15 Removing Forms (Fixed Form Paving)

a. Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least 12 hours. Forms shall be removed carefully so as to avoid damage to the pavement.

b. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated in Article 3.14 above. Where the Engineer considers that a major degree of honeycombing is present, the work will be considered defective and shall be removed and replaced. Any area or section so removed shall not be less than 2 meters in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 1.5 meters in length shall also be removed and replaced. Minor honeycombing shall be pointed up with mortar composed of one part cement and two parts of fine aggregate by weight.

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501-3.16 Pavement Drains

- a. Pavement drains shall be installed under the shoulders and median at the locations indicated on the standard drawings, or as ordered by the Engineer, and in accordance with the details shown on the plans.
- b. The construction of the pavement drains and outlets shall be made in accordance with all the applicable provisions of Specification 605 - Underdrains.

501-3.17 Geotextile - Geotextile of the type indicated on the standard drawings shall be installed at the edge of the concrete pavement on the median side at the locations and in accordance with the details, shown on the standard drawings or ordered by the Engineer. The geotextile shall be bonded to the concrete pavement edge using an emulsified asphalt meeting the requirements for a tack coat as described in Section 407-2 of Specification 407 - Bituminous Tack Coat.

501-3.18 Sealing Joints and Cracks

- a. All joints and cracks shall be sealed before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Sawed joints shall be water washed immediately after sawing and thoroughly dried prior to sealing.
- b. Joints shall be sealed with backer rods and sealants of the types specified on the standard drawings. Unless otherwise indicated on the plans, silicone joint sealant shall be one of the sealants incorporated into the Authority's approved list. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and the joint faces shall be clean and surface dry when the seal is applied.

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- c. The sealing material shall be applied to each joint opening to conform to the details shown on the standard drawings or as directed by the Engineer.
- d. Silicone joint sealant shall be applied directly from the original container into the joint using an air-powered pump and in accordance with the manufacturer's recommendations. Immediately after placement and before a skin forms, the silicone sealant shall be tooled to force it against the joint faces and to recess the bend to the required depth.
- e. Hot poured elastic type sealant shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surfaces of the concrete pavement shall be removed immediately and the pavement surfaces cleaned. The use of sand or similar material as a cover for the seal will not be permitted.
- f. Preformed elastomeric gaskets for sealing joints, when specified or authorized, shall be of the cross sectional dimensions shown on the plans. Seals shall be installed and anchored as shown on the plans with suitable tools without elongation, and secured in place with an approved lubricant adhesive which shall cover both sides of the concrete joints. The seals shall be installed in a compressed condition and shall at time of placement be below the level of the pavement surface by approximately 6 mm. The seals shall be in one piece for the full width of each transverse joint.
- g. Cracks that occur in the concrete pavement prior to its acceptance shall be sealed in accordance with all the applicable requirements of Specification 507 - Joint and

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Crack Sealing in Portland Cement Concrete Pavement, at the Contractor's expense.

h. At joints between concrete and bituminous mixes, such as at asphalt shoulder joint with concrete pavement, any trace of asphalt shall be thoroughly cleaned from the face of the concrete to which the sealant will be bonding by saw cutting tightly along the concrete.

501-3.19 Protection of Pavement

a. The Contractor shall protect the pavement and its appurtenances against damage caused by both public traffic and traffic from his own operations. This protection shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, or any other protective devices required by Part VI of the MDUCT of the Department of Transportation and Public Works. This work shall be performed in accordance with the requirements of Specification 638 - Maintenance and Protection of Traffic. However, unless specifically provided in the contract documents, no direct payment will be made for this work and it shall be a subsidiary obligation of the Contractor with its cost included in the pay item for Portland cement concrete pavement.

b. Any damage to the pavement due to lack of protection or negligence on the part of the Contractor, occurring prior to acceptance, shall be repaired or the pavement replaced at the expense of the Contractor.

501-3.20 Opening to Traffic

a. The Engineer will decide when the pavement will be opened to traffic. The pavement will not be opened to traffic until test specimens conforming to the requirements of Article

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501-2.08 have attained a compressive strength of 3,000 pounds per square inch, unless otherwise authorized by the Engineer.

b. Prior to opening to traffic, the joint and crack sealing shall have been completed and the pavement shall have been thoroughly cleaned.

c. Unless specifically authorized by the Engineer, the Contractor's equipment will not be permitted on or allowed to use the pavement until the above requirements are met.

501-3.21 Tolerance in Pavement Thickness

a. The thickness of the pavement will be determined by average caliper measurement of cores tested in accordance with AASHTO T 148.

b. For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as 300 linear meters of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be 300 meters plus the fractional part of 300 meters remaining. One core will be taken at random by the Engineer in each unit. When the measurement of the core from a unit is not deficient by more than 5 mm. from the plan thickness, full payment will be made. When such measurement is deficient by more than 5 mm. but not more than 25 mm. from the plan thickness, two additional cores at intervals not less than 100 meters will be taken from the unit and the average thickness of the three cores determined. If the average of the three cores is not deficient by more than 5 mm. from plan thickness, full payment will be made. However, if the average thickness of the three cores is deficient by more than 5 mm. but not more than 25 mm from the plan thickness, an adjusted unit price as

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provided in paragraph 501-5.01a. will be paid for the area represented by these cores.

c. Other areas such as intersections, entrances, crossovers, ramps, etc. will be considered as individual units, and the thickness of each unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as the Engineer may select in each unit, one core will be taken for each 300 square meters of pavement, or fraction thereof, in the unit. If the core so taken is not deficient by more than 5 mm. from the plan thickness, full payment will be made. If the core is deficient in thickness by more than 5 mm. but not more than 25 mm. from the plan thickness, two additional cores will be taken from the area represented and the average of the three cores determined. If the average measurement of these three cores is not deficient by more than 5 mm. from the plan thickness, full payment will be made. However, if the average thickness of the three cores is deficient by more than 5 mm. but not more than 25 mm. from the plan thickness, an adjusted unit price as provided in paragraph 501-5.01a. will be paid for the area represented by these cores.

d. In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 5 mm. will be considered as the specified thickness plus 5 mm., and measurements which are less than the specified thickness by more than 25 mm. will not be included in the average.

e. When the measurement of any core is less than the specified thickness by more than 25 mm., the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 3-meter intervals parallel to the centerline in each direction from the affected location until in each direction a core is found which is not deficient

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by more than 25 mm. Areas found deficient in thickness by more than 25 mm. shall be evaluated by the Engineer and if, in his judgment, the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price.

f. The Contractor shall backfill at his expense all the core holes with an approved P.C. concrete mixture after removing dirt, water or other foreign material from the hole.

501-4 METHOD OF MEASUREMENT

501-4.01

a. Concrete pavement will be measured by the square meter complete in place and accepted. The width for measurement will be the width of the pavement shown on the typical cross section of the plans, and any additional widening where called for, or as otherwise directed in writing by the Engineer. The length will be measured horizontally along the centerline of each roadway or ramp. The measurement will not include bridge approach slabs which are included under Specification 601 - Structural Concrete.

b. Pavement drains will be measured by the linear meter of length along the top of the drain pipe completed and accepted.

c. The furnishing and installation of all dowels and tie bars, joint sawing, joint and crack fillers and sealing, geotextiles, curing and all other miscellaneous materials and operations required to complete the pavement will not be measured for direct payment but shall be a subsidiary obligation of the contractor with their cost included in the pay item for P.C. concrete pavements.

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501-5 BASIS OF PAYMENT

501-5.01 The accepted quantities of concrete pavement measured as provided in paragraph 501-4.01a. above will be paid for at the contract unit price per square meter. Such price and payment shall be full compensation for furnishing, placing, finishing and curing the concrete and for all materials, equipment, tools, labor, and incidentals necessary to complete the pavement as required by the plans and specifications, provided however, that pavement found to be deficient in thickness and/or strength and allowed to remain in place will be paid for at a reduced unit price determined as follows:

- a. Where the average thickness of the pavement, determined as provided in Article 3.21 above, is deficient by more than 5 mm. but not more than 25 mm. the reduction in unit prices will be computed in accordance with the following formula:

$$R = 3.6D$$

where R = Percentage reduction in unit price.

D = Deficiency in mm. in the thickness of the concrete pavement in excess of 5 mm.

- b. Where the compressive strength of the concrete is deficient but the pavement is allowed to remain under the provisions of Article 501-2.09, the reduction in unit price will be computed in accordance with the provisions of Article 601-5.05 of Specification 601 - Structural Concrete, except that the moving average shall consist of six cylinders sets instead of three sets.

- c. The percentage reductions in unit price for thickness and compressive strength deficiencies will be cumulative but will not exceed 90 percent of the contract unit price for any deficient concrete allowed to remain place.

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d. Where the deficiency in thickness of the pavement is in excess of 25 mm. but it is allowed to remain in lieu of removal and replacement, payment for such deficient area retained will be limited to 10 percent of the contract unit price.

e. No additional payment over the contract unit price will be made for any pavement which has an average thickness in excess of that shown on the plans or a strength in excess of that specified.

501-5.02 The accepted quantity of pavement drains measured as provided in paragraph 501-4.02b. above will be paid for at the contract unit price per linear meter. Such price and payment shall be full compensation for all required excavations, furnishing and placing of drain pipe, granular filter material and concrete for outlet slabs, and for all materials, equipment, tools, labor and incidentals necessary to complete the drains as required by the plans and specifications.

501-5.03 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|--|-----------------|
| Portland Cement Concrete Pavement..... | Square Meter |
| Pavement Drains..... | Linear Meter |

SPECIFICATION 502 – UNDERSEALING PORTLAND CEMENT CONCRETE PAVEMENT

502-1 DESCRIPTION

502-1.01 Scope

a. This work shall consist of testing the existing pavement to detect slab movement under load, drilling grout injection holes through the pavement, and pressure injection of a slurry type cement grout under the pavement to fill any voids in the base or subbase in order to stabilize and underseal the pavement. All work shall be performed at the locations shown on the plans or indicated by the Engineer, in accordance with these specifications, and in conformance with the lines, grades and details shown on the plans or established by the Engineer.

b. This work also includes the retesting of the slabs for stability after the initial undersealing has been completed and the regrouting, as directed by the Engineer, of pavement slabs where unsatisfactory stability remains. Additional retesting and regrouting shall be performed as directed by the Engineer.

c. Undersealing is normally the first step in the construction process of portland cement concrete pavement rehabilitation. Subsequent construction operations, in order of implementation, include:

1. Full depth slab replacement and partial depth patching (Specifications 503 and 504).
2. Installation of new dowels at cracks and joints (Specification 505).
3. Grinding of pavement to eliminate joint faulting and/or restore drainage and provide texturing (Specification 506).

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4. Cleaning, reshaping and sealing of joints and cracks (Specification 507).

d. Whenever the term joints is used in this specification, it should be understood to also include cracks when applicable.

502-2 MATERIALS

502-2.01 Grout Materials - Materials for the cement grout shall conform to the following specifications and requirements:

- a. Portland Cement - Specification 701.
- b. Limestone Dust - AASHTO M 17 as to grading and plasticity index. Limestone dust shall be spherical in shape. Dust containing mostly flat platelet grains or rhomboidal shaped grains will not be acceptable.
- c. Pozzolans and Fly Ash - ASTM C 618
- d. Mortar Sand - Specification 703-1 but grading shall be as follows:

| <u>Sieve Size</u> | | | | | |
|------------------------------|-------|--------|--------|---------|---------|
| | No. 4 | No. 8 | No. 50 | No. 100 | No. 200 |
| Percent Passing by Weight | 100 | 90-100 | 15-50 | 0-15 | 0-5 |

- e. Water - Specification 712-1.
- f. Additives - Chemical admixtures meeting the requirements of Specification 711-3 for water reducing and set accelerating, and superplasticizers, may be used as necessary to meet grout mix requirements but subject to prior approval by the Engineer.

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g. The Contractor shall submit for approval by the Engineer the materials and additives that he proposes to use in each grout mix prior to their use. Submittals shall include:

1. Limestone Dust - certified grading and plasticity index test reports.
2. Pozzolans - certified physical and chemical analysis reports.

502-2.02 Undersealing Grout Mixes

a. The bid items will designate the type or types of undersealing grout mixtures required. The various grout mixtures shall be proportioned as indicated in Table 502-1. When no specific mix type is indicated in the contract documents, Grout Type 2 shall be used, unless another grout type is approved by the Engineer.

TABLE 502-1

**UNDERSEALING GROUT MIXTURES
Mix Proportion in Percent by Weight of Dry Materials**

| <u>Dry Materials</u> | <u>Grout Types</u> | |
|----------------------|--------------------|----------|
| | <u>1</u> | <u>2</u> |
| Portland Cement | 25 | 25 |
| Limestone Dust | 75 | |
| Pozzolan or Fly Ash | | 75 |

b. Each grout mix shall be designed, in line with the materials proportions specified in Table 502-1, with the necessary water content and chemical admixtures to meet the following physical requirements:

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1. Fluidity - The quantity of mixing water used with the dry ingredients shall be that quantity which will produce a grout of such fluidity that the time of efflux from the specified flow cone will be a minimum of 14 seconds and a maximum of 22 seconds. The fluidity of the grout slurry shall be measured by the flow cone test method included in Specification 722, Measurement of Fluidity of Grout Mixtures.
 2. The grout mixture shall be capable of forming a hard, compact and insoluble mass that will effectively fill voids under the pavement.
 3. Strength - The grout slurry shall attain a compressive strength at 7 days of not less than 800 psi when tested as per AASHTO T 106.
- c. The Contractor shall submit in advance the proposed grout mixes indicating the specific proportions of all components. For each grout slurry mix he shall submit certified reports of independent laboratory testing covering:
1. 1-day, 3-day and 7-day strengths.
 2. Flow cone times.
 3. Shrinkage and expansion observed. Expansion shall be determined as per ASTM C 940.
 4. Time of initial set determined as per AASHTO T 154.

502-2.03 Grout for Backfilling Injection Holes - The grout mix for permanently sealing the injection holes drilled into the pavement shall consist of any one of the following materials:

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- a. A rapid setting patching material meeting the requirements of Article 504-2.01i. of Specification 504.
- b. A fast setting non-shrinking sand/cement mortar mix or a concrete mix, to be approved by the Engineer, that will attain a compressive strength of 5,000 psi in 72 hours when tested as per AASHTO T 22.

502-3 CONSTRUCTION REQUIREMENTS

502-3.01 Equipment - The Contractor shall furnish all equipment, tools and other apparatus for the proper construction and acceptable completion of all the required work. It shall include at least the following items:

- a. Slab stabilization testing equipment composed of:
 - 1. A two axle truck with dual rear tires which shall be loaded to 18 kips on the rear axle evenly distributed between the two sides, with a driver and sufficient manpower to assist in the operation of the static load measuring gauges. Loadometer scales to check the truck axle loadings shall be furnished by the Contractor.
 - 2. Equipment to measure slab deflections and lift which shall be capable of detecting simultaneously the movement of the pavement edge or of any two outside slab corners adjacent to a joint or crack and the adjoining shoulder. The equipment shall have the capacity of making such measurements to 0.001 inch. A minimum of two gauge mounts, each with two gauges mounted on it, shall be furnished and maintained in good operating order by the Contractor.
- b. Drilling equipment shall include air compressors and rock drills or other device capable of drilling the injection holes, up to 2 inches in diameter, through the concrete

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pavement and base material. Rock drills shall not be heavier than 60 pounds and the downward pressure during drilling shall not exceed 200 pounds.

c. Grout batching equipment shall include weight hoppers and scales for each dry material or calibrated in increments that are equivalent to one 94-pound sack of cement. Aggregate scales shall be accurate to plus or minus 1% and cement scales shall be accurate to plus or minus 0.5%. However, the dry cement and pozzolan may be prepackaged in uniform volume sacks with the weight of cement in the mix in each sack clearly indicated.

d. Grout mixing equipment consisting of a water-tight batch mixer that is capable of blending the various materials into a homogeneous mixture. Water shall be batched through a meter or scale. When Type 2 grout is used, the mixing equipment shall consist of a high speed (800 to 2000 RPM) colloidal mixing machine that shall have a rotor operating in close proximity to a stator, creating a high shearing action and subsequent pressure release to make a homogeneous mixture.

e. A flow cone with all necessary components for the exclusive use of the Engineer and at least one more for the Contractor's use. The flow cones shall conform to the dimensions and other measurements detailed in Specification 722.

f. Grout pumping equipment consisting of a positive displacement cement injection pump, piston type or screw type worm pump, capable of applying up to 200 psi pressure at the end of the discharge pipe. The discharge lines shall be equipped with a pressure gauge a positive cut-off valve at the nozzle end, a bypass return line for recirculating the grout back into the mixer or holding tank, and a nozzle or device at the discharge end that will remain secure in the injection hole and be free of appreciable leaks.

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- g. Miscellaneous equipment includes a blow pipe with sufficient air pressure to dislodge loose debris and an auger of sufficient size and length as required to open clogged holes.

502-3.02 Preliminary Testing - All testing shall be performed by the Contractor on all joints and designated cracks within the indicated project sections using the loaded truck and the deflection measuring gauges to obtain slab deflection readings at each joint. The following procedures shall be followed:

- a. All testing shall be performed between the hours of midnight and 7:00 A.M.
- b. One set of gauges shall be positioned with one gauge referenced to the corner of each slab on both sides of the joint near the shoulder/pavement edge. The gauges will then be indexed to zero with no load on the slab on either side of the joint.
- c. The loaded test truck shall then be moved into position and stopped with the center of the 18 kip loaded axle about one foot behind the joint and the outside test wheel about one foot from the pavement/shoulder edge. Both gauges shall then be read and the reading recorded.
- d. Next the test truck shall be moved across the joint to a similar position about one foot forward of the joint and stopped. The gauges will again be read and these readings recorded.
- e. The Engineer will be responsible for reading the gauges and recording the deflections. All slabs with a deflection of more than 0.030 inch, or as shown on the plans, will require additional testing.
- f. The Engineer will be responsible for determining which slabs require stabilization by undersealing. This determination will be made on the basis of both the deflection

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measurements and observations made during the preliminary testing. Normally, all slabs with deflections in excess of 0.03 inch will require undersealing.

502-3.03 Drilling Injection Holes

a. The plans indicate the location and pattern of the holes for grout injection in each slab. The drilling work shall be started using the hole pattern and pumping sequence shown on the plans. The Engineer, or the Contractor, subject to the Engineer's approval, may subsequently alter this hole pattern if such changes improve the undersealing operations and results. However, only the actual number of holes drilled, not to exceed the number of holes per slab shown on the plans, will be considered for payment.

b. Holes shall be drilled of a size and shape that best provide a positive seal for the pumping nozzle, but not to exceed 2 inches in diameter. Initially the holes shall be drilled to a depth of approximately 8 inches beneath the bottom of the concrete pavement unless the Engineer approves an alternate depth. After the initial attempt at undersealing, the number, location and depth of all holes shall be as approved by the Engineer.

c. The Contractor shall exercise all necessary precautions during the drilling operations to insure that the slabs are not broken or cracked. Down pressure on the drill shall be held to a minimum, particularly in the bottom 4" of the slab, to prevent a cratering in the bottom of the slab. Any slab that contains a crack that extends through the drill hole will be considered to have been damaged during the process of the work and it shall be repaired, at the Contractor's expense, in accordance with Specification 507 or as directed by the Engineer.

502-3.04 Cleaning Injection Holes - After drilling and just prior to pumping the underseal grout, the drilled holes shall be air

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blown under sufficient pressure to remove debris and provide a passage for the grout. Subject to the Engineer's approval, a small cavity may be created in the base material to facilitate the initial spreading of the grout.

502-3.05 Grout Preparation

- a. After the cement and limestone, pozzolan, or fly ash have been placed in the mixer with the required water, they shall be mixed for at least 15 seconds. Any additives required will then be added and the mixing continued for at least another 15 seconds. The grout will then be transferred to the agitator from which it can be pumped.
- b. Cement or cement and limestone dust, may be added in the proper proportion to a mixed batch to produce the required consistency.
- c. Grout held in the mixer, or agitator, or in the injection pump or hose, for more than one hour after mixing shall not be used for undersealing.

502-3.06 Grout Pumping

- a. During the undersealing operations, a means of monitoring slab lift, acceptable to the Engineer, shall be implemented by the Contractor who shall provide the personnel and equipment necessary to satisfactorily control lift on every slab being undersealed.
- b. To fill all voids the pumping of grout will be required in holes designated by the Engineer. The nozzle of the discharge hose shall be secured in the hole in a manner that provides a seal adequate to maintain the grout pressure underneath the slab. The nozzle end shall not extend below the bottom of the concrete slab.

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c. Grout shall be pumped under pressure into each selected hole until there is indication that all cavities or voids have been filled. Maximum continuous pumping pressures to 100 psi will be permitted unless other lower values are specified by the Engineer to minimize slab rising. The pressure shall be monitored by an accurate pressure gauge in the grout line that is protected from the grout slurry.

d. Pumping into each hole shall be continued under close monitoring of the pressure gauge and the lift measuring devices until the complete filling of the voids within the range of the hole is evidenced by any one or more of the following conditions, at which time pumping shall cease:

1. The grout is observed flowing from hole to hole and/or is flowing out of adjacent holes, slab edges and cracks.

2. A rapid rise or excessive lift of the slab, or there are indications of a rise in the adjacent shoulder. A minimal lifting of the slab will generally be required to move grout into the existing cavities and voids but this lift should not exceed 0.05 inch total accumulative movement for each slab measured at the outside joint corner, unless otherwise approved by the Engineer.

3. The pressure gauge in the discharge line indicates a rapid rise in pressure, in no case should the pressure be allowed to exceed 200 psi.

e. The above procedure will be repeated at other holes until there is indication that all voids under the slab are filled. The plugging of ungrouted holes during grouting operations will not be permitted.

f. Any water displaced from the voids under the slab by the grout shall be allowed to flow freely.

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g. Excessive loss of grout through joints, cracks or other grout holes, or from the insertion and removal of nozzles shall not be allowed. Pay quantities for grout will be reduced by the Engineer accordingly when he determines that the Contractor has not taken appropriate measures to minimize grout loss.

h. The Contractor shall take the necessary precautions to prevent the slabs from cracking or breaking during the undersealing operation, including cracks that may be caused by differential lifting of slabs during pumping. Slabs determined to be cracked or broken during the undersealing operation due to the Contractor's negligence shall be repaired in accordance with Specification 507, or removed and replaced in accordance with Specification 503, as determined by the Engineer and at the Contractor's expense. Cracks emanating radially from an injection hole and transverse cracks that develop between adjacent holes will be presumed to have been caused by improper undersealing techniques and shall be repaired by the Contractor at no cost to the Authority.

502-3.07 Sealing of Injection Holes - Permanent Sealing - After a sufficient time has elapsed to allow the grout to set sufficiently, any undersealing grout left in the holes within the pavement shall be removed and the holes filled with an approved grout, as per Article 502-2.03, flush with the pavement surface. Filled holes that ravel out or become damaged shall be repaired.

502-3.08 Clean Up - Deposits of grout on the pavement or shoulders shall be removed and the surface cleaned before any traffic is permitted on the section. Other debris, spillage, and any other waste material shall be removed from the right-of-way each day.

502-3.09 Opening to Traffic - No traffic shall be permitted on the grouted slabs until at least 3 hours after having completed the backfilling of the injection holes.

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502-3.10 Retesting and Regrouting

- a. After grouted slabs have been under traffic for at least 12 hours they shall be retested for stability following the same procedures used for preliminary testing as specified in paragraphs a. to e. inclusive of Article 502-3.02.
- b. Slabs which show deflection of less than 0.02 inch or as otherwise indicated in the contract documents will be accepted as satisfactorily undersealed.
- c. Slabs which show deflections in excess of the above criteria will be regouted as directed by the Engineer and shall again be retested for stability. These will be accepted if within the deflection criteria.
- d. Slabs which continue to show deflection in excess of the established criteria after properly performed grouting and regrouting will be subject to one of the following actions as determined by the Engineer:

1. Be subjected to a third undersealing attempt by extending new grout holes into the subgrade.
2. Be designated for full depth removal and replacement of the whole slab or a portion of it. This work shall be performed and paid for under the requirements and conditions of Specification 503.
3. Be scheduled for correction by other means.

502-3.11 Construction Scheduling - The drilling of the holes and the grout pressure injection shall be so scheduled and performed that the grout injection is completed and the holes sealed on the same day that the holes are drilled. No injection holes shall be left open overnight except under unusual conditions beyond the control of the Contractor.

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502-4 METHOD OF MEASUREMENT

502-4.01 Testing - Preliminary slab deflection testing for void detection, when required, will be measured by each individual joint tested and accepted by the Engineer. Retesting of slabs for stability will be measured by the joint each time the joint or crack is retested up to and including a maximum of three tests.

502-4.02 Injection Holes - Drilling of injection holes will be measured by each hole drilled and accepted by the Engineer, regardless of depth.

502-4.03 Undersealing Grout Slurry - Will be measured by the number of 94-pound portland cement bags used in the total quantity of each type of grout slurry ordered mixed and used, and accepted by the Engineer.

502-5 BASIS OF PAYMENT

502-5.01 The accepted quantities of testing and retesting of slabs joints and cracks, determined as provided above, will be paid at the contract unit price for joint testing. Such price and payment shall constitute full compensation for all the satisfactory performance of each test as required by these specifications.

502-5.02 The accepted quantity of injection holes, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for the drilling, cleaning and resealing of each hole as required by the plans and specifications.

502-5.03 The accepted quantity of bags of cement, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for furnishing all materials, hauling, mixing and injecting the undersealing grout slurry, and the clean-up, as required by the plans and specifications.

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502-5.04 In addition to the above, payment under the unit prices listed below shall constitute full compensation for all materials, special measuring devices, equipment, tools, labor and incidentals necessary to complete each item required by the plans and specifications.

502-5.05 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|---|-----------------|
| Testing..... | Joint |
| Injection Holes..... | Each |
| Undersealing Grout – Cement..... (Grout Type_____) | Bag |

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503-1 DESCRIPTION

503-1.01 Scope

a. This work shall consist of the removal of existing Portland cement concrete pavement and its replacement with new Portland cement concrete pavement at the locations shown on the plans or indicated by the Engineer, in accordance with these specifications, and in conformance with the lines, grades, dimensions and details shown on the plans, standard drawings or established by the Engineer.

b. The work shall also include the removal of any existing unsuitable base course and unsuitable subgrade material and their replacement at the locations directed by the Engineer, in accordance with these specifications, and in conformity with the lines, grades, dimensions and details shown on the plans, standard drawings or established by the Engineer.

c. This work shall also consist of the construction of Portland cement concrete pavement (accelerated strength) with reinforcement constructed in accordance with these specifications and in conformity with the lines, grades, dimensions and details shown on the plans, standard drawings or established by the Engineer.

503-2 MATERIALS

503-2.01 New subgrade or subbase material shall meet the requirements of Specification 301 - Subbase Course.

503-2.02 New base course material shall meet the requirements of Specification 304 - Aggregate Base Course.

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503-2.03 Two classes of concrete are used for full depth pavement replacement: normal set concrete and accelerated strength concrete.

- a. Normal set concrete shall have a minimum compressive strength of 5,000 psi at 28 days and shall meet all the requirements for concrete materials, mix design, sampling and testing, and basis of acceptance specified in Articles 501-2.01, 501-2.02, 501-2.03, 501-2.07, 501-2.08 and 501-2.09 of Specification 501 - Portland Cement Concrete Pavement. This concrete will be used at the locations specifically indicated on the plans on multilane roadways where single lanes under reconstruction may remain closed to traffic until a minimum strength of 3,000 psi is attained.
- b. Accelerated strength concrete shall be designed to attain a compressive strength of 3,000 psi at 5 days. Slabs with accelerated strength concrete shall be reinforced. Reinforcing shall be No. 6 bars in both directions at 30 cm spacing located at the neutral plane of the slab. A 7.5 cm spacing of the reinforcing steel shall be maintained from all slab sides.
- c. Six (6) cores or six (6) cylinders, at the Contractor's option shall be taken, in accordance with AASHTO T-22, T-23 and T-24, as applicable, from each 125 square meters of concrete pavement or fraction thereof placed each day for testing at five (5) days. The specimens shall be taken and transported by the Contractor to the designated laboratory, under the supervision of the Material Testing Office. It shall be the Contractor's responsibility to coordinate the presence of a Material Testing Office representative, as well as with the designated laboratory, if delivery of the specimens is to be made outside of the laboratory normal working hours. No further retesting will be allowed.

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d. The specimens shall be delivered, during laboratory normal working hours, to the designated PRHTA laboratory by the Contractor no later than the third day after placement of the concrete. Failure by the Contractor to deliver the specimens within the specified time will result in an additional 20% deduction in the unit price which is paid for the affected lots. This penalty is in addition to that specified in article 503-5.03. Specimens delivered by the Contractor after the fourth day will not be accepted by the PRHTA laboratory for testing. Affected lots could either be rejected or accepted with 90% penalty at the option of the Authority.

e. The compressive strength level of the concrete pavement will be considered satisfactory if both of the following requirements are met by the 5 day core or cylinder sets:

1. The average of all sets of six consecutive tests (moving average) equals or exceeds the specified compressive strength of 5,000 psi for normal set concrete or 3,000 psi for accelerated strength concrete.
2. No individual test (average of specimens in a set) falls below the specified compressive strength of 500 psi.

f. In the case of cores, the compressive test strengths will be divided by 0.85 and the resulting value used for determining compliance with the requirements in paragraph e above.

g. When the moving average for the 5 day sets fails to meet the compressive strength requirement, the in-place concrete pavement will be considered deficient but will be accepted if the deficiency in the moving average does not exceed 500 psi, and if no individual set is deficient by more

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than 500 psi, but payment for the concrete represented by the failing averages will be paid for at the reduced unit price as specified in Article 503-5.03.

h. Should concrete used in the work fail to conform to the requirements in paragraph e above, the Contractor shall, at his expense, make corrective changes, subject to the approval of the Engineer, in the material mix proportions or in the concrete fabrication procedures, before placing additional concrete.

i. All concrete pavement represented by sets which indicate a compressive strength failing below the specified value by more than 500 psi will be considered deficient and will be rejected. Such lots may be accepted at the discretion of the Authority at a reduced price to be determined by the Authority on the basis of inspection and evaluation of the deficient pavement under traffic.

j. Concrete pavement that fails the acceptance criteria and is rejected shall be removed and disposed of at the Contractor's expense.

k. The Contractor shall backfill the cores holes with concrete the same day they are taken.

l. Cores will be taken in the middle of the slab, no cores will be permitted at the joints.

m. Intentionally Omitted.

503-2.04 Dowels and tie bars shall meet the requirements of AASHTO M 31 grade 60 billet-steel bars and shall be epoxy coated in conformance with the requirements of AASHTO M 284.

503-2.05 Epoxy resin adhesive for bonding the new concrete to the old concrete shall meet the requirements of Class I epoxy

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adhesive of AASHTO M 235 and M 234. Prior to use, the Contractor shall submit the technical literature on the proposed epoxy adhesive and certification by the manufacturer that it meets the specification requirements.

503-2.06 The epoxy grout to anchor the dowels and tie bars placed in drilled holes and to fill sawing overcuts shall be a low viscosity mortar or compound made with Class I or III epoxy resin adhesive (AASHTO M 235) with a mineral filler prepared and mixed according to the manufacturer's recommendations. The Contractor shall submit in writing for review and approval the composition and specific materials of the mix recommended by the manufacturer and certification that the proposed epoxy resin adhesive provided for the mortar mix meets the specification requirements.

503-3 CONSTRUCTION REQUIREMENTS

503-3.01 General - The removal and replacement of the damaged Portland cement concrete pavement shall be conducted one lane at a time following the sequence of operation and conditions specified in the contract documents or established by the Engineer. The work shall be performed in a manner that causes a minimum of inconvenience to public traffic and in conformance with all maintenance and protection of traffic requirements.

503-3.02 Removal of Existing Pavement

a. The areas of removal of the existing pavement shall be as shown on the plans and as directed by the Engineer. The minimum slab area to be removed shall be a full lane width by a minimum length of 2 meter measured parallel to the centerline. If any edge of a pavement area to be removed is within 1.5 meters of an existing joint, the area to be removed shall be extended to such joint.

b. Prior to the removal operation, a saw cut to the full depth of the existing pavement shall be made longitudinally

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along the existing lane joint and the shoulder joint, and transversely along the edges of the area to be removed. If found necessary and approved by the Engineer, one or more additional longitudinal cuts may be made within the area to be removed to facilitate the demolition and removal of the damaged concrete.

c. Overcutting beyond the limits of the areas marked for removal shall be held to a minimum. Overcuts shall be thoroughly cleaned of sawing slurry and other contaminants and those which are not to be finished as a joint shall be grouted with an approved low viscosity epoxy resin mortar.

d. Shoulders adjacent to the patch areas shall be cut longitudinally to the full concrete pavement depth and to a width not exceeding 30 centimeters, and the shoulder material removed to allow for the placement of side forms to hold the new concrete. This shoulder cut may extend beyond the transverse edge of the patch area to facilitate the placing and anchoring of the side forms. After completion of the pavement repair and removal of the side forms, the removed section of the shoulders shall be rebuilt with material substantially equal in type and quality to the existing shoulder material. All this work of shoulder removal and replacement shall be a subsidiary obligation of the Contractor under the pay item for the removal of Portland cement concrete pavement.

e. The existing concrete pavement within the designated patch areas shall be demolished and removed by the contractor exercising due care to avoid damaging the adjacent existing pavement and base course which are to remain. Ball breakers shall not be used to break the concrete. Removal of the broken concrete shall be by lifting out in one or more pieces using lift pins or other suitable devices. Any damage to adjacent pavement and base course to remain caused by the

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Contractor shall be repaired, at his expense, as directed by the Engineer.

503-3.03 Removal and Replacement of Existing Unsuitable Base, Subbase, and Subgrade Material

- a. Each patch area will be inspected by the Engineer after the existing pavement has been removed to determine the condition and adequacy of the base, subbase, and subgrade material. The Contractor shall excavate test pits at the locations and to the depth, not to exceed 60 centimeters, ordered by the Engineer.
- b. Where the Engineer determines that the existing material is unsuitable, the Contractor shall excavate and remove such unsuitable material within the area and to the depth established by the Engineer.
- c. If the existing base, subbase or subgrade is in a saturated condition, the Engineer may order construction of underdrains under a change or extra work order.
- d. The removed unsuitable material shall be replaced by the Contractor with approved subbase and base material to the depths shown on the plans or ordered by the Engineer. This backfill material shall be placed in layers not exceeding 15 centimeters in thickness and each layer compacted with mechanical tampers or small vibratory rollers to the satisfaction of the Engineer.

503-3.04 Disposal of Removed Material - The concrete pavement, shoulder material, and base and subgrade material removed from the patch areas shall be disposed of by the Contractor at his expense. To the extent possible, the removed material shall be used to flatten existing road section slopes at the locations and in the manner indicated by the Engineer. The unusable, excess removed material shall be disposed of outside the project right-of-way in areas

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selected by the Contractor. Copy of the necessary permits authorizing the use of the selected disposal areas shall be furnished by the Contractor to the Engineer.

503-3.05 Protection of Patch Areas

- a. The Contractor shall have available at all times sufficient sheet plastic material to cover patch areas being worked on to protect them from rainfall and minimize the penetration of water into the base and subgrade prior to placing the new concrete pavement.
- b. Temporary drainage trenches to dispose of any water accumulated in the work areas shall be constructed by the Contractor as shown on the plans or ordered by the Engineer. This work shall be a subsidiary obligation of the Contractor under for P.C. concrete pavement removal pay item.

503-3.06 New Dowels and Tie Bars

- a. Holes for new dowels and tie bar shall be drilled in the existing concrete pavement along the edges of the patch areas in accordance with the details and at the location shown on the plans, standard drawings or ordered by the Engineer. The drilling tools shall be held in a rigid frame to assure the correct vertical and horizontal alignment of the holes. The diameter of the holes shall be not more than 1/4" larger than the diameter of the corresponding dowel or the bar.
- b. Installation of all dowels and tie bars called for under this specification shall be as per standard drawings.

503-3.07 Preparation of Concrete Surfaces

The exposed sawn faces of the existing concrete pavement shall be thoroughly cleaned and shall be coated, except at longitudinal and transverse joints, with an approved epoxy resin adhesive

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approximately 10 to 20 mils thick. This epoxy bonding agent shall be placed in accordance with the manufacturer's instructions and at such time as to assure that it is still tacky when the new concrete pavement is placed.

503-3.08 Mixing, Placing, Finishing and Curing the Replacement Concrete - The replacement Portland cement concrete shall be mixed, placed, finished and cured in accordance with all applicable requirements included under Specification 501 - Portland Cement Concrete Pavement modified, and supplemented as indicated below:

- a. The paving equipment required shall be a finishing screed and vibrator to insure that the replacement concrete is thoroughly consolidated to form a homogenous mass conforming to the required lines, grade and cross section.
- b. Forms shall be used on the shoulder side of the slabs being patched.
- c. Joints shall be constructed in accordance with the details shown on the plans and in conformance with Specification 507 - Joint and Crack Sealing. All original longitudinal and transverse joints shall be maintained.
- d. The surface shall be finished and given a tined texture as required in Article 3.12 of Specification 501 - Portland Cement Concrete Pavement unless final texturing under Specification 506 - Grinding Portland Cement Concrete Pavement is to be provided to meet grade and drainage requirements.
- e. The Contractor shall at all times utilize such approved measures as are necessary to keep all pavement and shoulder surfaces adjacent to these operations reasonably clean of excess concrete, grout and other materials.

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503-3.09 Adverse Hot Weather Conditions

- a. Concrete shall be properly protected from adverse hot weather conditions before, during and after placement. The initial concrete placement temperature shall not exceed 100°F (38°C). All necessary precautions shall be taken to see that the concrete is promptly placed on arrival at the job and immediately vibrated after placement. The concrete shall be protected from excessive drying during finishing and curing operations which shall be performed without delay as soon as the concrete is ready for them.
- b. Concrete shall not be placed when any combination of air temperature, relative humidity, concrete temperature and wind speed is expected to result in an evaporation rate in excess of 0.2 pound per square foot per hour. Table 503-1 may be used as a guide to determine concrete speeds and relative humidity combination at which evaporation rates in excess of 0.2 lb/ft.²/hr, at an ambient temperature of 90°F, may be expected.

**TABLE 503-1
TYPICAL CRITICAL CONCRETE TEMPERATURES FOR
VARIOUS WIND-SPEEDS AND RELATIVE HUMIDITIES (1)**

| Concrete Temperature - °F | Relative Humidity % at 10 mph | Relative Humidity % at 15 mph | Relative Humidity % at 20 mph | Relative Humidity % at. 25 mph |
|---------------------------------|--|--|--|---|
| 100 | 80 | 95 | (2) | (2) |
| 95 | 65 | 80 | 85 | 90 |
| 90 | 45 | 60 | 70 | 75 |
| 85 | 30 | 45 | 55 | 60 |
| 80 | 20 | 35 | 40 | 45 |
| 75 | 10 | 20 | 30 | 35 |

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1. Maximum concrete temperatures at an ambient temperature of 90°F for different wind speeds and relative humidities to limit the rate of evaporation to about 0.2 lb/ft.²/hr.
 2. Required relative humidities in excess of 100%.
- c. The Engineer may authorize, at his discretion, the placing of concrete pavement at concrete temperatures in excess of the critical values if the Contractor submits for approval acceptable procedures which will effectively reduce the evaporation rate throughout the placement area to less than 0.2 lb/ft.²/hr. Such procedures shall include one or more of the following:
1. Shading and cooling aggregates and other components at the batching plant.
 2. Dampening subgrade and forms.
 3. Erecting windbreaks to effectively reduce the wind speeds throughout the placement area.
 4. Placing concrete at the lowest possible temperature by reducing the time between mixing and placing.
 5. Fog spraying throughout the placement area to effectively increase the relative humidity.
 6. Placing concrete at lower ambient temperature such as early morning, late afternoon or at night.

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- d. Water reducing and retarding admixtures may be used to offset the undesirable effects of placing concrete at high temperatures provided the design mix requirements for the specified strength are met.

503-3.10 Construction Scheduling - The removal of existing pavement and underlying materials, and the placement of replacement materials and pavement shall be so scheduled and performed that no area remains open for more than 48 hours.

503-4 METHOD OF MEASUREMENT

503-4.01 The removal of existing Portland cement concrete pavement, shall be measured by the square meter, to the nearest tenth, of pavement acceptably removed and disposed of.

503-4.02 The removal of unsuitable base course, subbase and subgrade material ordered by the Engineer will not be measured for direct payment. This work shall be a subsidiary obligation under the pay items of subbase and base course replacement materials.

503-4.03 The subbase and base course material used to replace existing unsuitable subgrade, subbase and base materials shall each be measured by the cubic meter, to the nearest tenth, of compacted material accepted in final position.

503-4.04 Replacement Portland cement concrete pavement slabs and portions thereof each class called for and accepted by the Engineer will be measured by the square meter, to the nearest tenth, using the average squared dimensions.

503-4.05 Dowels and tie bars and their placement will not be measured for direct payment. These shall be a subsidiary obligation of the Contractor with their cost included in the unit price of the replacement slab.

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503-4.06 Joint sealing, including any required sawing, will be measured and paid for separately under Specification 507 - Joint and Crack Sealing. Texturing will be measured and paid for under Specification 506 - Grinding Portland Cement Concrete Pavement. When required, tined finish shall be a subsidiary obligation.

503-4.07 Reinforcing steel for Portland cement concrete pavement (accelerated strength) or Portland cement concrete slab replacement (accelerated strength) will not be measured directly for payment. It shall be a subsidiary obligation of the Contractor with its cost included in the unit price for the accelerated strength concrete pavement pay items.

503-5 BASIS OF PAYMENT

503-5.01 The accepted quantities of existing concrete pavement removed, determined as provided in paragraph 503.4.01 above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for all required sawing, removal of the concrete and shoulder material, and the satisfactory disposal of all removed concrete pavement, shoulder, base course material and the removal and replacement of subbase. It also includes the replacement of the shoulder material removed and the construction of any required temporary drainage trenches.

503-5.02 The accepted quantities of replacement of subbase, and base course material, determined as provided in paragraph 503-4.03 above, will be paid for at the respective contract unit prices. Such prices and payment shall constitute full compensation for the test pits; the excavation and disposal of unsuitable base, subbase and subgrade material; and the furnishing, placing, compacting and finishing of the specified replacement materials.

503-5.03 The accepted quantities of replacement Portland cement concrete pavement, determined as provided in paragraph 503-4.04 above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for the furnishing and

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installation of the required dowels and tie bars; the preparation of the concrete surfaces, including the epoxy resin adhesive coating; and the furnishing, placing, curing and finishing of the Portland cement concrete pavement; provided however, that pavement found deficient in thickness and/or strength and allowed to remain in place will be paid for at a reduced unit price determined as follows:

- a. Where the average thickness of the pavement, determined as provided in Article 501-3.21 of specification 501, is deficient by more than 5 mm, but not more than 25 mm. The reduction in unit prices will be computed in accordance with the following formula:

$$R = 3.6D$$

Where R = Percentage reduction in unit price.

D = Deficiency in mm. in the thickness of the concrete pavement in excess of 5 mm.

- b. Where the compressive strength of the concrete is deficient but the pavement is allowed to remain under the provisions of Article 503-2.03, the reduction in unit price will be computed in accordance with the following formula:

$$R = 0.5D$$

Where R = Percentage reduction in unit price of the concrete.

D = Deficiency in psi of the moving average value from the specified strength.

The price reduction will be applied to all the volume of concrete represented by the cylinder or core sets in a six sets moving average subject to the following:

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1. The highest three (3) compressive strength values obtained from cylinders or cores from each lot of 125 the cylinders or cores shall be used to determine the average of the set.
 2. No price reduction will be applied when the deficiency “D” in the moving average does not exceed 100 psi.
 3. The price reduction will be applied to any given volume of concrete only once. It will be applied on the basis of the value of the first deficient moving average of which it is a component.
- c. The percentage reductions in unit price for thickness and compressive strength deficiencies will be cumulative but will not exceed 90 percent of the contract unit price for any deficient concrete allowed to remain in place.
- d. Where the deficiency in thickness of the pavement is in excess of 25 mm. but it is allowed to remain in lieu of removal and replacement, payment for such deficient area retained will be limited to 10 percent of the contract unit price.
- e. No additional payment over the contract unit price will be made for any pavement which has an average thickness in excess of that shown on the plans or a strength in excess of that specified.

503-5.04 In addition to the above, payment under the unit prices listed below shall constitute full compensation for all materials, equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

**SPECIFICATION 503 – REMOVAL AND REPLACEMENT
OF PORTLAND CEMENT CONCRETE PAVEMENT, FULL
DEPTH**

503-5.05 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|--|-----------------|
| Removal of Portland Cement Concrete Pavement.... | Square Meter |
| Replacement of Subbase Material..... | Cubic Meter |
| Replacement of Aggregate Base Course..... | Cubic Meter |
| PCC Slab Replacement (Normal Set) (thickness _____)..... | Square Meter |
| PCC Slab Replacement (Accelerated Strength) (thickness _____)..... | Square Meter |
| Portland Cement Concrete Pavement (accelerated strength) (thickness _____)..... | Square Meter |

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

504-1 DESCRIPTION

504-1.01 Scope - This work shall consist of the partial depth patching of spalls, potholes, and corner breaks in portland cement concrete pavement by removing the asphaltic concrete or broken, damaged, or disintegrated concrete pavement from spalled areas of the pavement surfaces and patching the damaged areas with approved patching materials in accordance with this specification, and in conformity with the existing pavement cross section, the details shown on the plans or as established by the Engineer.

504-2 MATERIALS

504-2.01 Materials for repairing and patching portland cement concrete pavement shall conform to the following requirements:

- a. Portland Cement - Specification 701-1 but shall be Type I or III cement.
- b. Fine Aggregate for Portland Cement Concrete - Specification 703-1 but the use of manufactured sand will not be permitted.
- c. Coarse Aggregate for Portland Cement Concrete - Specification 703-2 but the grading shall be limited to designated size 1" to No. 4 in Table 703-2, unless otherwise authorized by the Engineer. Grading distribution may be altered to meet mix requirements provided the limiting maximum and minimum size values are complied with.
- d. Aggregates for Epoxy Mortar and Epoxy Concrete - Shall comply with the epoxy manufacturer's recommendations as to type and grading.
- e. Admixtures for Portland Cement Concrete - Type C or E water-reducing and accelerating admixture meeting AASHTO M 194 requirements. Calcium chloride meeting the requirements of Specification 712-2 may be used.

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

- f. Epoxy Resin Adhesive for Epoxy Mortar and Epoxy Concrete - Class II or III as per AASHTO M 235.
- g. Epoxy Resin Adhesive for Bonding Plastic Concrete to Hardened Concrete - Class I as per AASHTO M 235.
- h. Curing Materials - Specification 711-1.
- i. Rapid Setting Patching Material - Shall be nonmetallic, with a color similar to portland cement concrete and shall have the capability of being mixed and placed in a similar manner, except that this material must have accelerated hardening characteristics and be capable of providing a permanent patch in concrete that can be subjected to traffic within two hours of placement. The material shall comply with the following requirements:
 - 1. Patching material may be of two classes:
 - (a) Premixed material which can be used as received by adding water or, if required, an activator solution according to the manufacturer's instructions.
 - (b) Non-premixed material which contains no aggregate. The aggregate, fine and/or coarse, shall be added by the user in accordance with the manufacturer's recommendations.
 - 2. Material shall be factory packaged in strong moisture proof bags or containers capable of withstanding shipping, handling and storage without breakage. Material shall have a minimum storage life of one year. Each container shall be clearly labeled including:

**SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF
PORTLAND CEMENT CONCRETE PAVEMENT**

- (a) Manufacturer’s name and batch number
- (b) Component designation, if two components.
- (c) Mixing directions and ratios.
- (d) Potential hazards and precautions.

3. The mixed material shall comply with the following physical requirements:

| <u>Requirement</u> | <u>Test Method</u> |
|--------------------------------|--------------------|
| Setting Time | ASTM C-807 |
| Initial Set – 7 to 20 minutes | |
| Final Set – 30 minutes maximum | |
| Compressive Strength | AASHTO T 106 |
| 2 hours – 1200 psi | |
| 24 hours – 3000 psi | |

4. Acceptance of the material will be on the basis of certification by the manufacturer that the material meets these requirements. However, failure by the material to perform adequately in actual use shall be just cause for rejection regardless of certification.

504-2.02 Patching mixtures shall be of three types as follows:

- a. Accelerated Strength Portland Cement Concrete - Shall comply with the applicable requirements of Section 501-2 of Specification 501- Portland Cement Concrete Pavement, modified and supplemented as follows:

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

1. The cement, aggregates and other mix components shall comply with the requirements specified in Article 504-2.01 above.
 2. The mix shall attain a compressive strength of 5,000 psi at 72 hours. The contractor shall submit the proposed mix design together with laboratory reports on the tests performed on the trial mixes for approval by the Engineer.
 3. Slump of the mix shall be in the range of 1 to 3 inches inclusive at the time of placing.
- b. Rapid Setting Patching Materials - shall comply with the requirements specified in Article 504-2.01i. above and shall be mixed in accordance with the manufacturer's instructions.
- c. Epoxy Mortar and Epoxy Concrete-Mix designs shall be compatible with portland cement concrete pavement and shall not exhibit excessive surface slicking at 90°F curing temperatures. Epoxy concrete shall attain a compressive strength of 3,000 psi in 24 hours.

504-3 CONSTRUCTION REQUIREMENTS

504-3.01 General - Concrete patching operations shall be conducted in one lane at a time and in a manner that offers minimum inconvenience to public traffic. The work shall be accomplished in coordination with other operations in progress within an area. Work within an area shall be performed after undersealing has been completed but before the grinding operation begins.

503-3.02 Equipment

- a. The Contractor shall provide sawing equipment adequate in size and power to saw the joints and other sides of the areas to be patched to the required widths and depths.

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

- b. Pneumatic and electric chipping hammers may be used to remove defective concrete but these shall not be heavier than 30 pounds.
- c. Portable concrete mixers of adequate capacity may be used to mix the accelerated strength portland cement concrete for patching.

504-3.03 Spall Areas Identification and Preparation

- a. Each transverse contraction joint shall be sounded for defective areas by striking the pavement surface alongside each joint with a carpenter's hammer, a solid steel rod, a chain drag, or other similar tools. Areas less than 15 centimeters in length and 4 centimeters in width at the widest point shall not be repaired under this specification but shall be filled with joint sealant. Areas determined to be defective shall be removed to the depth of sound concrete. Spall repairs shall have a minimum depth of 5 centimeters and be limited to a maximum depth of 10 centimeters. When need for repair exceeds this maximum, the repair shall be accomplished by full depth slab repair and paid for under the appropriate items of Specification 503.
- b. Transverse and longitudinal joints shall be saw cut to the full depth of the spall plus 2.5 centimeters. The saw cut shall be 0.63 centimeters (1/4") wide and shall extend out 2.5 centimeters beyond the limits of the spall repair area in each direction. A 0.63 cm. wide piece of closed-cell polyethylene foam shaped to fit the saw cut shall be placed at these joints prior to placing the patching material to prevent bridging of the joint.
- c. In the event of back-to-back spall repairs, the 0.63 cm. closed-cell polyethylene foam shall be supported during placing operations so as to maintain a true straight joint line. The method used shall be approved by the project Engineer.

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

- d. Spall repairs on the same side of the joint that are 60 centimeters or less apart shall be combined into one repair.
- e. A saw cut 5 centimeters deep shall be made on all sides of the repair area where there is no joint to reestablish, as shown on the plans.
- f. The existing concrete surfaces within the areas to be repaired shall be thoroughly cleaned, immediately before patching is begun, by sand or water blasting to leave them free of oil, dust, dirt, loose material and other contaminants.

504-3.04 Spall Patching

- a. After preparation, the spalled areas shall be repaired by any of the three patching methods described below, selected by the Contractor. Normally, Repair Method No. 1 should be used for the spall areas requiring repair depth of 5 centimeters or more.
- b. Patches that are completed and found to contain cracks, shrinkage, or become damaged during construction or by traffic prior to final acceptance shall be removed and replaced at the Contractor's expense.

504-3.05 Repair Method No. 1, Accelerated Strength Concrete

- a. The bottom and vertical side walls of the repair area shall be completely coated with a film of an approved epoxy bonding agent approximately 10 to 20 mils thick.
- b. The concrete patching mixture shall be deposited in the area while the epoxy is still tacky and shall be vibrated or spaded to completely fill the area of the patch. The concrete shall be screeded to the proper grade and allowed to remain undisturbed until the water sheen disappears from the surface. The concrete shall then be covered with wet burlap or

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

membrane curing compound. Curing shall continue until the section is opened to traffic.

504-3.06 Repair Method No. 2, Rapid Setting Patching Material

- a. In addition to the requirements included in Article 3.03 above, the surface of the areas to be repaired with this mixture shall be prepared in accordance with the manufacturers' written recommendation.
- b. Handling, mixing, placement, consolidation, screeding and curing of the patching material shall be in accordance with the manufacturer's written instructions as approved by the Highway Authority Materials Office. Curing shall continue until the section is opened to traffic.

504-3.07 Repair Method No. 3, Epoxy Mortar or Epoxy Concrete

- a. The epoxy resin and the catalyst shall be preconditioned before blending to produce a blended liquid that is between 75° and 90°F. The epoxy components shall be mixed in strict compliance with the manufacturer's mixing recommendations before aggregates are added to the mixture. The mixture shall be blended in a suitable mixer to produce a homogeneous mass. Only that quantity of material that is usable in one hour shall be mixed at one mixing and material that has begun to generate appreciable heat shall be discarded.
- b. The entire surface of the repair areas shall be primed with neat blended epoxy immediately before the mixture is placed. Priming shall include overlapping the surface of the area adjacent to the patch. The mixture shall be placed and tamped with sufficient effort to eliminate voids and to thoroughly compact the product. The surface shall be screeded to produce the required finish. The repaired area

SPECIFICATION 504 – PARTIAL DEPTH PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

shall be allowed to remain undisturbed for at least 3 hours before it is subjected to traffic.

504-3.08 Reestablishment of Joints - Transverse and longitudinal joints in patched areas shall be reestablished by sawing and sealing in accordance with the details shown on the plans and in conformance with the requirements of Specification 507 - Joint and Crack Sealing.

504-3.09 Texturing - Final texturing of patches, if required, will be provided under Specification 506 - Grinding Portland Cement Concrete Pavement.

504-3.10 Construction Scheduling - The patching operations shall be so scheduled and performed that the surface cleaning and coating, and the placing of the patching material, for each patch area is completed on the same day.

504-4 METHOD OF MEASUREMENT

504-4.01 Partial depth patching will be measured for payment by the square meter, to the nearest tenth, of patching areas complete in place and accepted.

504-4.02 Reestablishment of joints will be measured and paid for separately under Specification 507 - Joint and Crack Sealing. Texturing will be measured and paid for under Specification 506 - Grinding of Portland Cement Concrete Pavement.

504-5 BASIS OF PAYMENT

504-5.01 The accepted areas of partial depth patching, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for all required sawing; removal and disposal of asphaltic concrete patching material or the spalled, broken, or damaged portland cement concrete pavement; cleaning and preparing the patch areas; furnishing and placing any required epoxy bond coat; furnishing,

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placing, finishing and curing the patching mixture; repairing the adjacent shoulder, if required; and for all materials, equipment, tools, labor and incidentals necessary to complete the work as required by the plans and specifications.

504-5.02 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|--|-----------------|
| Partial Depth Patching – P.C. Concrete Pavement..... | Square Meter |

SPECIFICATION 505 – INSTALLATION OF NEW DOWELS IN PORTLAND CEMENT CONCRETE PAVEMENT

505-1 DESCRIPTION

505-1.01 Scope

- a. This work shall consist of the installation of new dowels at cracks and joints for load transfer purposes in existing portland cement concrete pavement at the locations shown on the plans or indicated by the Engineer, and in accordance with these specifications and the plan details.
- b. This work does not cover the installation of dowels and tie bars which are included as part of full depth concrete pavement slab replacement under Specification 503.

505-2 MATERIALS

505-2.01 Dowels - shall be reinforcing steel bars, plain or deformed as indicated on the plans, of the dimensions shown, meeting the requirements of Grade 60 billet-steel bars in Specification 709-1, and epoxy coated in conformance with Specification 709-3.

505-2.02 Polymer Concrete - The polymer concrete shall be a high strength, non-shrink grout material conforming to the following requirements:

- a. The material shall consist of a liquid resin, powder filler and fine aggregate. When properly mixed in accordance with the manufacturer's instruction, the mortar shall attain 80% of its full strength within 3 hours under field conditions at temperatures ranging from 60° to 100°F.
- b. The material shall be mixed in the field with selected aggregates capable of being troweled in place. Mixing instructions shall be printed on each container.

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c. The fine aggregates shall conform to Specification 703-1 and the gradation shall be as recommended by the manufacturer and as approved by the Authority.

d. The polymer concrete grout shall attain the following physical properties within 24 hours:

Min. Compressive Strength as per AASHTO T 106..... 8,000 psi

Maximum Shrinkage (linear) as per AASHTO T 160... 0.01%

e. The mix design shall give a high enough slump to allow the polymer concrete to flow freely around the bar. The proposed mix shall be submitted to the Authority together with samples of the mix components for testing and approval prior to use.

f. The pot life of the polymer concrete shall have a range of 8 to 15 minutes minimum and be consistent over a temperature range of 60° to 100°F.

g. The Contractor shall submit written data on the materials properties for the polymer concrete to include:

1. Certified test reports on the compressive strengths and shrinkage.
2. Hardness.
3. Surface and wear resistance.
4. Recommended temperature usage and curing time.
5. Storage characteristics.

SPECIFICATION 505 – INSTALLATION OF NEW DOWELS IN PORTLAND CEMENT CONCRETE PAVEMENT

505-3 CONSTRUCTION REQUIREMENTS

505-3.01 General

- a. The installation of new dowels shall be conducted one lane at a time following the sequence of operations and conditions specified in the contract documents or established by the Engineer. The installation of dowels shall be performed after the pavement full and partial depth patching operations have been completed in an area and prior to grinding and sealing of joints and cracks.
- b. The work shall be conducted in a manner that causes a minimum of inconvenience to public traffic and in conformance with all maintenance and protection of traffic requirements.

505-3.02 Equipment - The Contractor shall have available all necessary equipment and tools to properly construct the work. Required equipment includes:

- a. Self propelled concrete saw equipped with diamond blade or approval equal. The saw shall be capable of cutting the concrete pavement to the required depth to form the kerfs (slots) to accommodate the new dowels.
- b. Light-weight pneumatic or electric chipping hammers, not heavier than 30 pounds, to chip the kerfs into the concrete pavement after sawing the edges. The chipping hammers shall not spall or damage the concrete adjoining the kerfs.
- c. Sand or water blasting equipment and air compressor with accessory hoses and nozzles for cleaning the kerfs prior to grouting.

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505-3.03 Implantation of Dowels

- a. Kerfs shall be diamond saw cut in the pavement as shown on the plans or as directed by the Engineer. The saw cuts shall be made parallel to the centerline of the pavement to the depth shown in the plan details for the full length of the dowel. The concrete between the saw cuts shall be removed with a chipping hammer, or other acceptable method, to form the kerf. After removal of the concrete, the kerf shall be sand or water blasted and then blown clear with compressed air.
- b. Dowels of the size and type specified on the plans shall be installed in the kerfs. Each dowel shall be placed on a support to allow the grout to surround it. All dowels shall be provided with a filler board or styrofoam material where the dowel crosses the joint or crack to prevent the intrusion of the grout into the joint or crack and to form the joint at the kerf.
- c. Plain dowel bars at transverse joints shall have one half of their length thoroughly coated with an approved bituminous material or heavy lubricant to prevent the polymer concrete grout from binding to that portion of the dowel, or they shall be provided with a metal sleeve conforming to Article 709-1.04 of Specification 709 at the option of the Contractor.
- d. Deformed dowels placed at cracks shall not be coated with any material other than the specified epoxy coating.

505-3.04 Grouting

- a. The polymer concrete grout shall be prepared in accordance with the manufacturer's instructions and the approved design mix.
- b. Following the placement of the dowel, each kerf shall be filled with the specified grout. The mix shall be placed

SPECIFICATION 505 – INSTALLATION OF NEW DOWELS IN PORTLAND CEMENT CONCRETE PAVEMENT

and tamped to insure no voids are left and the kerf filled flush with the pavement. The surface shall be screeded and given the required finish. Curing shall be as per the manufacturer's instructions.

c. Polymer concrete may not be held in the mixer or pump for more than the manufacturer's specified pot life after mixing. Any material held for longer time shall be rejected at no cost to the Authority.

505-3.05 Acceptance

a. Any location where the pavement is spalled or cracked due to poor construction techniques in the cutting of the kerfs shall be repaired by the Contractor at no cost to the Authority. Materials for spall repairs shall be subject to approval by the Authority.

b. Prior to final acceptance, implanted dowels that fail to exhibit effective bond, either polymer concrete to old concrete or bars to polymer concrete, shall be replaced at the Contractor's expense. Bond failures shall be detected by visual inspection of each installation after having been opened to normal traffic for at least fifteen days.

505-4 METHOD OF MEASUREMENT

505-4.01 Dowels, whether plain or deformed, will be measured by the number of individual units installed complete and accepted.

505-5 BASIS OF PAYMENT

505-5.01 The accepted quantity of new dowels, determined as provided above, will be paid for at the contract price per unit. Such price and payment shall constitute full compensation for the cutting and cleaning of the kerfs, the furnishings and placing of the dowels and the polymer concrete grout, and for all other materials,

**SPECIFICATION 505 – INSTALLATION OF NEW DOWELS
IN PORTLAND CEMENT CONCRETE PAVEMENT**

equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

505-5.02 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|-----------------|-----------------|
| New Dowels..... | Each |

SPECIFICATION 506 – GRINDING PORTLAND CEMENT CONCRETE PAVEMENT

506-1 DESCRIPTION

506-1.01 Scope - The work shall consist of grinding portland cement concrete pavement to substantially eliminate joint faulting and/or to restore proper drainage, riding characteristics and texturing to the pavement surface. The work shall be performed at the locations shown in the plans or indicated by the Engineer, in accordance with these specifications, and in conformance with the lines, grades and details shown on the plans or established by the Engineer.

506-2 MATERIALS

506-2.01 No materials are specified.

506-3 CONSTRUCTION

506-3.01 General

a. Pavement undersealing (Specification 502), slab jacking (Specification 508), full and partial depth patching (Specifications 503 and 504), and installation of load transfer dowels (Specification 505) shall have been completed prior to the grinding operations.

b. Areas to be ground are as indicated on the plans or as established by the Engineer. Patched areas will normally be provided final texturing by grinding. Grinding of bridge decks and roadway shoulders will not be required unless indicated on the plans or required to improve drainage.

506-3.02 Equipment

a. Grinding and texturing shall be done utilizing diamond blades mounted on a self-propelled machine that has been designed for grinding and texturing of pavements. The equipment shall be capable of providing the required texture and shall be such that it will not cause strain or damage to the

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underlying surface of the pavement. Grinding and texturing equipment that causes excessive ravels, aggregate fractures, spalls, or disturbance of the transverse and/or longitudinal joints will not be permitted.

b. As an alternate to the grinding equipment with diamond blades specified in paragraph a. above, the Contractor may submit for evaluation by the Authority modified pavement grinding and texturing equipment which utilizes carbide tipped teeth such as is used for cold milling of pavements. The evaluation by the Authority will be performed as follows:

1. The Contractor shall, at his expense, grind a test section at a location selected by the Authority using the proposed equipment. The test section shall be 100 meters in length and one full lane in width. The equipment shall grind the pavement to a uniform matted texture with differences between the high and low points of 0.16 to 0.24 centimeters (1/16 to 3/32 inches) and with the distance center to center of each strike area of approximately 0.5 centimeters.
2. The Contractor shall maintain a record of the speed of rotation of the drum and the forward speed of the equipment required to obtain the desired texture.
3. The Authority will check the ground test section for uniformity of the texture and will evaluate its rideability, tire noise and skid resistance by driving motor vehicles at different speeds over the surface. The Authority will be the sole judge of whether the alternate equipment proposed meets the grinding requirements, produces an acceptable surface and does not cause excessive ravels, spalling or disturbance of the joints.
4. If the Authority approves the alternate equipment, the Contractor shall make at least three

SPECIFICATION 506 – GRINDING PORTLAND CEMENT CONCRETE PAVEMENT

plastic resin molds, 0.45M by 0.45M in area, of the approved test section texture. Two of these molds shall be delivered to the Authority for use in checking the results of the subsequent grinding operations.

5. A prospective contractor or subcontractor may request the Authority to test and prequalify his proposed equipment, at his expense, under these procedures and prior to bidding on a project. Such testing would be conducted on a test section selected by the Authority.

6. Equipment prequalified or qualified on a previous project need not be tested again provided it is in a condition and is operated as required to produce a texture matching molds approved by the Authority in previous tests. However, the Authority may require verification retesting at its discretion.

c. All grinding equipment shall be satisfactorily maintained and the diamond blades or carbide tips replaced as necessary to obtain the required results during the grinding operations.

506-3.03 Grinding Procedures

a. The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface of the required textures as per Article 506-3.04 below. Grinding shall be performed in the direction opposite to the normal traffic flow while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and acceptable riding surface.

b. The entire areas designated on the plans and established by the Engineer shall be ground until the pavement surfaces of adjacent sides of transverse joints and

SPECIFICATION 506 – GRINDING PORTLAND CEMENT CONCRETE PAVEMENT

cracks are in the same plane. The operation shall result in a pavement that conforms to the required cross section. It is the intention of this specification that the faulting at joints and cracks be eliminated, that the overall riding characteristics be within the limits specified, and that substantially all of the pavement surface be textured. Extra depth grinding to eliminate minor depressions in order to provide texturing for all of the pavement surfaces will not be required but at least 90% of the surfaces designated for grinding shall be textured.

c. The Contractor shall use appropriate equipment, such as a vacuum pump system, to remove grinding residue and slurry from the grinding operation for proper disposal at approved locations. Solid residue shall be removed from pavement surfaces before it is blown by traffic action or wind. Residue shall not be permitted to flow across lanes used by public traffic or into gutters or drainage facilities.

506-3.04 Final Surface Finish

a. The grinding process shall produce a pavement surface that is true to grade and cross section and with a texture of uniform in appearance.

1. When the diamond blades grinding equipment is used, the texture shall consist of parallel longitudinal corrugations that present a corduroy type appearance of narrow ridges. The peaks of the ridges shall be approximately 0.16 centimeters (1/16") higher than the bottom of the grooves. These corrugations shall be evenly spaced throughout the pavement at approximately 0.55 centimeters between grooves.

2. If the alternate cold milling type equipment is approved for grinding, the finished texture shall be as approved by the Authority under the testing and evaluation specified in Article 506-3.02b.

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- b. Pavement or shoulders adjacent to ground pavement areas shall also be ground when necessary to maintain an adequate cross slope for drainage.

506-3.05 Surface Testing

- a. After completion of the grinding process the ground pavement surfaces will be tested with a 3-meter straightedge furnished by the Contractor. Testing will be done both parallel to and normal to the centerline.
- b. All areas showing high spots of more than 3 mm. in 3 meters shall be further ground at the Contractor's expense to within the 3mm. tolerance.
- c. Ground areas showing surface deviations in excess of 7 mm. below the 3-meter straightedge shall be raised to the required elevation by partial depth patching, at the Contractor's expense if caused by the Contractor's operations.
- d. Straightedge requirements apply across transverse joints and repaired cracks but not across longitudinal joints or outside the ground areas.

506-4 METHOD OF MEASUREMENT

506-4.01 Pavement grinding will be measured by the square meter, to the nearest tenth, of pavement ground. The quantity of pavement grinding to be measured for payment will be determined by multiplying the width of the area ground by the length ground.

506-5 BASIS OF PAYMENT

506-5.01 The accepted area of ground pavement, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for furnishing all materials, equipment, tools, labor and incidentals necessary to

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complete the work as required by the plans and specifications,
including the removal of the residue and the cleaning of the
pavement.

506-5.02 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|------------------------------|-----------------|
| Grind Concrete Pavement..... | Square Meter |

SPECIFICATION 507 – JOINT AND CRACK SEALING IN PORTLAND CEMENT CONCRETE PAVEMENT

507-1 DESCRIPTION

507-1.01 Scope

- a. This work shall consist of the cleaning, refacing and sealing of joints and cracks in existing portland cement concrete pavement, including pavement having slabs or portions thereof being removed and replaced or patched, in accordance with these specifications and in conformity with the details shown on the plans or established by the Engineer.
- b. The existing joints and cracks to be sealed include all longitudinal, transverse and shoulder joints shown on the plans or designated by the Engineer. Also included are all joints to be reestablished and new joints developed under full depth and partial depth patching operations performed under Specifications 503 and 504.
- c. This work does not include the sealing of joints in new portland cement concrete pavement being constructed under Specification 501 as such joints are included under that specification. The sealing of the common longitudinal joint between the new and old pavements, and between the new pavement and new shoulders, on widening projects is also not included as such work is a subsidiary obligation of the new pavement under Specification 501.
- d. As used throughout this specification, the term joint also refers to cracks unless it is otherwise noted.

507-2 MATERIALS

507-2.01 Joint sealants shall be of the types specified in the plans and shall conform to the applicable requirements of Article 705-1.01 of Specification 705-Joint Materials. Unless otherwise specified, silicone joint sealant shall be used in all joints and cracks except in the joints between portland cement concrete pavements and

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asphalt shoulders where the AASHTO M 173 hot-poured elastic type filler shall be used.

507-2.02 Backer rod material shall be compressible, non-shrinkable, non-absorptive, and non-reactive with the joint sealant, such as stitched cotton piping cord, closed cell polyethylene foam rod, neoprene foam rubber or approved equal. The backer rod shall conform to the requirements of the manufacturers of the specific sealant to be used. The backer rod diameter shall be slightly larger than the width of the joint and such that, when placed in the joint space, it will support the sealant at its proper depth, and prevent the sealant from leaking around and underneath it. The backer rod diameter shall conform to the dimensions specified on the standard drawings for various joint widths.

507-2.03 Sealant and backer rod material shall be subject to inspection, testing, and approval by the Engineer before incorporation into the work. The contractor shall submit a written statement of origin, composition, and manufacturer of the joint materials proposed for use in the work. For the proposed sealant, the contractor shall submit manufacturer's certification that the material complies with the specification requirements.

507-3 CONSTRUCTION REQUIREMENTS

507-3.01 General

- a. All scheduled pavement repairs called for in the contract to be performed contiguous to the joints and cracks, including grinding operations if applicable, shall be completed prior to the joint sealing operations.
- b. Joint and crack sealing operations shall be conducted in one lane at a time in a manner that causes a minimum of inconvenience to public traffic and in conformance with all maintenance and protection of traffic requirements. Particular care shall be exercised to protect the traveling

SPECIFICATION 507 – JOINT AND CRACK SEALING IN PORTLAND CEMENT CONCRETE PAVEMENT

public from any hazard or damage from the cleaning and sawing operations.

507-3.02 Equipment - The Contractor shall furnish and use appropriate equipment, and tools to perform the required clearing, widening, refacing, and sealing of joints. All proposed equipment is subject to approval by the Engineer prior to its use. Necessary equipment and tools includes:

- a. Adequate routing tools for removing old sealant, capable of maintaining accurate depth and width control and which will not cause spalling of the joint edges. These may be adjustable routers, joint plows, or other mechanical tool approved by the Engineer.
- b. Water-cooled, self-propelled power saws with diamond and/or abrasive blades designed for sawing hardened concretes for use in refacing widening and deepening the existing joints as required but without damaging the sides, bottom or top edges of the joints. Blades may be single or gang type with one or more blades mounted in tandem for best cutting. The saws shall be adequately powered to cut the specified opening with not more than two passes of the saw through the joint.
- c. For sawing irregular cracks, a special power saw is required. It shall meet the above requirements, but it shall have swivel mounted small diameter blades to allow following closely the crack line.
- d. High-pressure water jet machine capable of discharging a water stream of up to 2,000 psi pressure at 22 gallons per minute, for use for cleaning purposes.
- e. Portable air compressors with hoses and nozzles, capable of delivering a minimum volume of air of 150 cubic feet per minute at not less than 90 psi at the nozzles. The

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compressor shall be equipped with the suitable traps capable of removing all oil and surplus water in the compressed air.

f. A self-propelled, vacuum pick up sweeper capable of removing all loose sand, water, joint material and debris from the pavement surface.

g. Air-powered pumps for pumping silicone sealant directly from the original container into the joints.

h. Portable applicators for hot-poured sealant materials, when such sealants are used, capable of heating and extruding the sealant in one operation. The units shall comply with and be used in conformity with the sealant manufacturers recommendation. The equipment shall have a melting kettle of the double boiler, indirect heating type, using oil as a heat transfer medium. The kettle shall have an effective mechanically operated agitator. It shall be equipped with a positive thermostatic temperature control and temperature gage, and a direct-connected pressure-type extruding device with nozzle or nozzles shaped for insertion in the joints to be filled. The applicators shall be designed so that the sealant will circulate through the delivery hose and return to the kettle when not sealing a joint or crack. The nozzle tip shall be equipped with a metal cross-bar to assure that the top of the sealant fed into the opening is level with the indicated tolerance below the pavement surface. The hoses and applicator wands shall be insulated for the entire length from the kettle to the nozzle.

i. The contractor shall furnish to the Engineer two 18” stem thermometers for checking the temperature of the hot-poured sealant. The temperature range of the thermometer shall be such as to allow checking the compliance with the specification requirements.

507-3.03 Removal of Existing Material - All in place old sealant and extraneous material shall be removed from the designated

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joints and cracks using the approved equipment and tools. The material shall be removed to the depth required to accommodate the backer rod and sealant as indicated in the standard drawings for the various types and widths of joints. The material and debris removed from the joints shall be removed from the pavement to prevent recontamination of the joints.

507-3.04 Refacing of Joints and Cracks

- a. The cleaned joints and cracks shall be refaced by sawing with an approved power-driven concrete saw to obtain the specified width and depth as per the standard drawings, to remove any remaining old sealant and to provide exposure of newly cleaned concrete. All joints, except cracks, shall be sawed in a straight line. Cracks shall be sawed following the crack line. A uniform width of cutting shall be maintained.
- b. Immediately after the sawing is completed and prior to sealing, the sawn cut and adjacent concrete pavement surface shall be cleared thoroughly by flushing with a high pressure water jet using a multiple pass technique until all traces of old sealant, debris and other waste from the sawing that might prevent bonding have been removed. Adjacent open joints that have been previously cleared shall be protected from contamination by the sawing and cleaning operation.

507-3.05 Cleaning Prior to Resealing - Immediately prior to the placement of the backer rod and sealant, the joints shall be thoroughly flushed again with a high pressure water jet to remove any remaining cuttings and debris. The flow of water shall be carefully controlled to prevent damage to the joints and excessive water penetration into the base material. After the water flushing, the joints shall be blown out with compressed air to remove all traces of debris and moisture and insure that the joints are dry and clean for sealing.

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507-3.06 Installation of Backer Rod

- a. After the joints have received the final cleaning and are dry, the backer rod or blocking media shall be installed in the bottom of the joint using a steel wheel or other device approved by the Engineer. Care shall be exercised to insure that the backer rod is not stretched or twisted during installation and that it is uniformly located at the depth below the top of the slab specified on the plans.
- b. The Contractor shall carefully check the final width of each joint and crack and select the appropriate size of backer rod or blocking media. Backer rods shall be round; however, in joints wider than 1", the blocking media may be cut from an approved material which is compatible with the sealant to be used. If a primer is required, it shall be applied before installing the blocking media.

507-3.07 Progress of Joint Preparation

- a. Joint preparation and sealing operations shall be a continuous process. Unsealed joints shall not be left open for more than one day after removal of old sealant, initial cleaning and refacing, to prevent the intrusion of moisture, incompressibles and dust.
- b. The final stages of joint preparation including the final water jet cleaning and air blowing, and the placing of backer rod or blocking media, shall be limited to the length of joints that can be sealed during the same working day.

507-3.08 Installation of Sealant

- a. Silicone joint sealant shall be applied directly from the original container into the joint using an air-powered pump in accordance with the manufacturer's recommendations and with the details shown on the plans. Immediately after placement and before a skin forms, the silicone sealant shall

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be tooled to force it against the joint faces and to recess the bead to the required depth.

b. Hot-poured joint sealant shall be heated in the melting kettle of the portable applicator to within the temperature range recommended by the manufacturer. Sealant that has been overheated or subjected to heating for over three hours, or that remains in the applicator at the end of the day's operation, shall be withdrawn and wasted.

c. No joint sealant shall be installed until the joint to be sealed has been inspected and approved by the Engineer.

d. The joints and cracks shall be sealed as soon as possible, and during the same day of the final cleaning and the placing of the backer rod or blocking media. The faces of the joint shall be clean and surface dry at the time of application of the sealant. Installation of the sealant shall commence at the highest point of the joint to be sealed.

e. The joints shall be filled with sealant from the bottom up, under pressure, and in a neat and workmanlike manner using the specified equipment. Care shall be taken that the sealant fills the joint uniformly, is well bonded to the concrete, is free of voids or entrapped air, and so that upon completion of the work the surface of the sealant is no less than 1/8 inch nor more than 3/8 inch below the pavement surface. The Contractor shall "spot up" or refill all low joints before acceptance.

f. Upon completion of the sealing of a joint, any excess sealing material or other residue on the surface of the pavement shall be promptly removed and the pavement left in a clean condition.

507-3.09 Opening to Traffic - Traffic shall not be permitted over sealed joints during the curing period and until the sealant is tack free so that debris from traffic does not embed into the sealant.

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Curing period shall be as recommended by the sealant manufacturer but not less than one hour.

507-4 METHOD OF MEASUREMENT

507-4.01 The sealing of pavement joints and cracks and pavement/shoulder joints will be measured by the linear meter of joint of each type sealed and accepted. No separate measurement will be made of joints and cracks resealed at the direction of the Engineer because of improper installation or damage caused by the Contractor's operations.

507-5 BASIS OF PAYMENT

507-5.01 The accepted quantities of joints and cracks sealed, measured as provided above, will be paid for at the contract unit price per linear meter. Such price and payment shall constitute full compensation for all the sawing, cleaning and sealing, including the furnishing of all required materials, and for all equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

507-5.02 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|---|-----------------|
| Sealing of PCC Pavement Joint and Cracks... | Linear Meter |
| Sealing of Pavement/Shoulder Joint..... | Linear Meter |

SPECIFICATION 508 – JACKING PORTLAND CEMENT CONCRETE PAVEMENT

508-1 DESCRIPTION

508-1.01 Scope - This work shall consist of raising and supporting existing settled portland cement concrete pavement and bridge approach slabs to the desired grade through the process of injecting under pressure a cement grout mixture beneath the pavement. The work shall be performed at the locations indicated on the plans or selected by the Engineer, in accordance with these specifications and in conformance with the lines, grades and details shown on the plans or established by the Engineer.

508-2 MATERIALS

508-2.01 Grout Materials - The portland cement, limestone dust, pozzolans, fly ash, mortar sand, water and additives for the grout mixes shall comply with all the requirements specified in Article 2.01 of Specification 502 - Undersealing Portland Cement Concrete Pavement.

508-2.02 Grout Mixes for Jacking

- a. The plans and bid items will designate the type or types of jacking grout mixtures required. The grout mixtures shall be proportioned as indicated in Table 508-1. When no specific mix type is indicated in the contract documents, Grout Types 3 or 4 may be used at the option of the Contractor, unless another grout type is approved in writing by the Engineer.

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TABLE 508-1

**JACKING GROUT MIXTURES
Mix Proportion in Percent by Weight of Dry Materials**

| <u>Dry Materials</u> | <u>Grout Types</u> | | | |
|----------------------|--------------------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> |
| Portland Cement | 25 | 25 | 25 | 25 |
| Limestone Dust | 75 | | 25 | |
| Pozzolan or Fly Ash | | 75 | | 25 |
| Mortar Sand | | | 50 | 50 |

b. Each grout mix shall be designed in line with the materials proportions specified in Table 508-1 and with the necessary water content and chemical admixtures to meet the following physical requirements:

1. Fluidity - The quantity of mixing water used with the dry ingredients shall be that quantity which will produce a grout of such fluidity that the time of efflux from the specified flow cone will range from 16 to 26 seconds for Grout types 2 and 4, and 22 to 33 seconds for Grout types 1 and 3. A more fluid mix having a time of efflux of 9 to 15 seconds may be used during the initial injection at each hole. The fluidity of the grout mixture shall be measured by the flow cone method as per Specification 722, Measurement of Fluidity of Grout Mixtures. Measurement of fluidity shall be made not less than twice a day for each type mix being used.

2. The grout mixture shall be capable of forming a hard, compact and insoluble mass that will effectively fill voids under the pavement.

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3. Strength - The grout slurry shall attain a compressive strength at 7 days of not less than 800 psi when tested as per AASHTO T 106.

c. The Contractor shall submit in advance the proposed grout mixes indicating the specific proportions of all components. For each grout slurry mix he shall submit certified reports of independent laboratory testing covering:

1. 1-day, 3-day and 7-day strengths.
2. Flow cone times.
3. Shrinkage and expansion observed. Expansion shall be determined as per ASTM C 940.
4. Time of initial set determined as per AASHTO T 154.

508-2.03 Grout for Backfilling Injection Holes - The grout mix for permanently sealing the injection holes drilled into the pavement shall consist of any one of the following materials:

- a. A rapid setting patching material meeting the requirements of Article 504-2.01 of Specification 504.
- b. A fast setting non-shrinking sand/cement mortar mix or a concrete mix, to be approved by the Engineer, that will attain compressive strength of 5,000 psi in 72 hours when tested as per AASHTO T 22.

508-3 CONSTRUCTION REQUIREMENTS

508-3.01 Equipment - The Contractor shall furnish all equipment, tools and other apparatus for the proper performance and completion of the required work. It shall include but not be limited to, the following items:

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- a. Drilling equipment shall include air compressors and rock drills or other devices capable of drilling the injection holes, 1 1/2 to 2 1/2 inches in diameter, through the concrete pavement and base material. Rock drills shall not be heavier than 60 pounds and the downward pressure during drilling shall not exceed 200 pounds.
- b. Grout batching equipment shall include weight hoppers and scales for each dry material or be calibrated in increments that are equivalent to one 94-pound sack of cement. Aggregate scales shall be accurate to plus or minus 1% and cement scales shall be accurate to plus or minus 0.5%. However, the dry cement and pozzolan may be prepackaged in uniform volume sacks with the weight of cement in the mix in each sack clearly indicated.
- c. Grout mixing equipment shall consist of a water-tight batch mixer that is capable of blending the various materials into a homogeneous mixture. Water shall be batched through a meter or scale. When Type 2 grout is used, the mixing equipment shall consist of a high speed (800 to 2000 RPM) colloidal mixing machine that 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. For the other mix types a paddle type mixer may be used. An agitator shall be provided if the grout is not to be pumped immediately after mixing.
- d. Fluidity testing equipment with all necessary components for the exclusive use of the Engineer and at least one more set for the Contractor's use. The flow cones shall conform to the requirements of Specification 722.
- e. Grout pumping equipment shall consist of a positive displacement cement injection pump, piston type or screw type worm pump, capable of applying up to 600 psi pressure at the end of the discharge pipe. The discharge lines shall be equipped with a pressure gauge, a positive cut-off valve at the

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nozzle end, a bypass return line for recirculating the grout back into the mixer or holding tank, and a nozzle or device at the discharge end that will remain secure in the injection hole and be free of appreciable leaks.

f. Cylindrical wooden plugs or other approved plugs that can effectively plug the drill holes until the grout has set.

g. Grout packers that can be inserted into the drilled holes to seal them while the grout is being pumped.

h. Miscellaneous equipment including a blow pipe with sufficient air pressure to dislodge loose debris and an auger of sufficient size and length as required to open clogged holes.

508-3.02 Removal of Overlays - The Contractor shall totally remove any existing asphaltic overlays prior to initiating the pavement jacking operations. This work shall be a subsidiary obligation of the Contractor under the jacking grout pay item.

508-3.03 Drilling Injection Holes

a. The plans indicate the location and pattern of the holes for grout injection under each slab. The drilling work shall be started using the hole pattern and pumping sequence shown on the plans. The Engineer, or the Contractor, subject to the Engineer's approval, may subsequently alter this hole pattern if such changes improve the jacking operations and results. However, only the actual number of holes drilled, as authorized by the Engineer, will be considered for payment

b. In general, holes should not be spaced less than 30 cm. or more than 45 cm. from a transverse joint or slab edge. The holes should be spaced no more than 1.8 m. center to center in order to limit the size of the slab area raised by pumping any one hole. Where the slabs are cracked additional holes may be required.

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c. Holes shall be drilled of a size and shape that best provide a positive seal for the pumping nozzle, but not to exceed 2 1/2 inches in diameter. Initially the holes shall be drilled to a depth of approximately 8 inches beneath the bottom of the concrete pavement unless the Engineer approves an alternate depth. After the initial attempt at pumping and jacking, the number, location and depth of all holes shall be as approved by the Engineer.

d. The Contractor shall exercise all necessary precautions during the drilling operations to insure that the slabs are not broken or cracked. Down pressure on the drill shall be held to a minimum, particularly in the bottom 4" of the slab, to prevent spalling or cratering in the bottom of the slab. Any slab that contains a crack that extends through the drill hole will be considered to have been damaged during the process of the work and it shall be repaired, at the Contractor's expense, in accordance with Specifications 505 and 507, or as directed by the Engineer.

e. After drilling and just prior to pumping the jacking grout, the drilled holes shall be air blown under sufficient pressure to remove debris and provide a passage for the grout. A small cavity may be created in the base material to facilitate the initial spreading of the grout.

508-3.04 Grout Preparation

a. After the cement and limestone, pozzolan, fly ash or mortar sand, have been placed in the mixer with the required water, they shall be mixed for at least 15 seconds. Any additives required will then be added and the mixing continued for at least another 15 seconds. The grout shall then be pumped or transferred to an agitator from which it can be pumped.

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- b. Cement, cement and limestone dust, or cement and mortar sand may be added in the proper proportion to a mixed batch to produce the required consistency.
- c. Grout held in the mixer, or agitator, or in the injection pump or hose, for more than one hour after mixing shall not be used in the work and will not be paid for. Rejected grout shall be disposed at the Contractor's expense at locations approved by the Engineer.

508-3.05 Monitoring System

- a. Unless otherwise provided in the plans, the string line method described below will be used to monitor the grout pumping sequence and control the raising of the slabs to assure that the final profile meets the desired grade.
- b. Small blocks 3/4 in. in height will be set on the pavement surface along the outer and inner edges. A string line will be set over the blocks at an elevation of the final grade plus 3/4 inch. As the pumping proceeds, the operators and the inspector can observe the exact amount the slabs are being lifted at each point within the pavement section being jacked.

508-3.06 Jacking Procedures

- a. Grout pumping shall be done over the entire section in such a way that no great strain is developed at any one place.
- b. The nozzle of the discharge hose shall be secured in the hole, using a rubber packer if necessary, in a manner that provides a positive seal adequate to maintain the grout pressure beneath the slab. The nozzle or packer end shall not extend below the lower surface of the concrete slab.
- c. When pumping, continuous monitoring of slab movement shall be exercised and the slab movement shall be

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carefully controlled to achieve the desired result without cracking the slab. The slab shall be raised only a small amount at a time, not more than 1/4 in. higher than any other part of the slab or of those slabs adjacent to it. Adjacent slabs shall be kept within 1/4 in. of the plane of the slab being raised to avoid cracking.

d. Pumping should always be started in the middle of the depressed area to be raised and extend in both directions longitudinally, as the section is brought up to its desired elevation and until the entire slab reaches the desired grade. Pumping should always begin at the outside holes and then follow with the inside row of holes. The order of pumping shall be taken as a general guide and constant checks must be made using the string line to monitor the process and make any adjustments in procedure that may be necessary.

e. Continuous pumping pressures of 200 psi are permitted and pressure of 300 psi will be allowed but for short periods only. Brief pressure rises to 600 psi, not exceeding 10 seconds, will be allowed in the event the pavement is bonded to the subbase.

f. Excessive loss of grout through joints, cracks or other grout holes, or from the insertion and removal of nozzles shall not be allowed. Pay quantities for grout will be reduced by the Engineer accordingly when he determines that the Contractor has not taken appropriate measures to minimize grout losses and these exceed 10% of grout successfully injected.

g. The Contractor shall take the necessary precautions to prevent the slabs from cracking or breaking during the jacking operations, including cracks that may be caused by differential lifting of slabs during pumping. Slabs determined to be cracked or broken due to the Contractor's negligence shall be repaired in accordance with Specifications 505, 506 and 507, or removed and replaced in accordance with

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Specifications 501 or 503, as determined by the Engineer and at the Contractor's expense. Cracks emanating radially from an injection hole and transverse cracks that develop between adjacent holes will be presumed to have been caused by improper jacking techniques and shall be repaired by the Contractor at no cost to the Authority.

h. Contiguous slabs shall be raised in sequence as a unit as indicated in paragraph c. above to avoid failure and cracking at the longitudinal joint which contains tie bars or may be keyed. Where the maintenance of traffic or other conditions require that jacking be performed by individual lanes, the longitudinal joint shall be sawed with mechanical saws to the full depth of the slab to permit the free movement of the slabs when raised. Upon completion of the raising operations, the longitudinal joints shall be fully restored by retrofitting new dowels under Specification 505 and sealing under Specification 507.

508-3.07 Tolerances

- a. The pavement slabs shall be within $\pm 1/4$ in. of the desired grade when the jacking is completed.
- b. Pavement slabs raised above the $1/4$ in. tolerance, but not over one inch, shall be brought to within $1/4$ in. of the specified grade by grinding in accordance with Specification 506 - Grinding Portland Cement Concrete Pavement, at the Contractor's expense. Pavement slabs raised in excess of one inch above the specified grade may be subject to removal and replacement at the Contractor's expense.

508-3.08 Changed Conditions

- a. In the event the Engineer determines that continued grout injection at any specific location with major voids, is no longer economically feasible, he may direct the Contractor to cease grout injection at that location. The Contractor will be

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paid at the unit price for the materials used up to that point and the tolerance requirements will not apply to such location.

b. The Engineer, at his discretion, may delete any location or may add new locations to be raised. Variation in the plan quantity at any specific location will not be considered cause for renegotiation of the contract unit prices.

c. During construction, conditions may be encountered such as in paragraph a. above, or may arise through no fault of the Contractor, which in the opinion of the Engineer may make impractical the raising by jacking of some pavement slabs so scheduled. The Engineer may order, in lieu of jacking, that such slabs be rehabilitated through any combination of the procedures covered in Specifications 502 through 507 inclusive.

508-3.09 Sealing of Injection Holes

a. Temporary Sealing - After the grouting has been completed at any one hole, the nozzle shall be removed and the hole plugged immediately with a tapered wooden plug to prevent back pressure from forcing the grout back out through the hole.

b. Permanent Sealing - After a sufficient time has elapsed to allow the grout to set sufficiently so that back pressure will not force it out through the hole, the temporary plugs shall be removed. Any grout remaining in the hole within the pavement shall then be removed and the hole filled with an approved grout, as per Article 508-2.03, flush with the pavement surface.

508-3.10 Approach Slab-Bridge Deck Joints - The rehabilitation and resealing of joints between approach slabs and bridge decks, if required, shall be performed by the Contractor as a subsidiary obligation under the pavement jacking pay items.

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508-3.11 Opening to Traffic - No traffic shall be permitted on the grouted slabs until at least 3 hours after having completed the backfilling of the injection holes.

508-3.12 Shoulder Adjustments

a. The Contractor shall adjust the shoulders, with the materials indicated on the plans, as necessary to match the grade of the adjacent jacked concrete pavement. This work will be performed, measured and paid for under the corresponding specifications and pay items of the materials used.

b. The Contractor shall provide and maintain adequate signing and protective devices at the pavement/shoulder edge until the vertical drop-off caused by the jacking is corrected by the necessary shoulder adjustment.

508-3.13 Clean Up - Deposits of grout on the pavement or shoulders shall be removed and the surface cleaned before any traffic is permitted on the section. Other debris, spillage, and any other waste material shall be removed from the right-of-way each day.

508-4 METHOD OF MEASUREMENT

508-4.01 Injection Holes - Drilling of injection holes will be measured by each hole drilled, sealed and accepted by the Engineer, regardless of depth.

508-4.02 Grout Mix Jacking - Will be measured by the number of 94-pound portland cement bags used in the total quantity of each type of grout mix for jacking ordered mixed and used, less any deductions for rejected grout and excessive waste, and accepted by the Engineer.

508-4.03 Full Depth Joint Sawing - The full depth sawing of longitudinal joints between contiguous lanes will be measured by the

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linear meter of joint ordered sawed, retrofitted with dowels, sealed and accepted.

508-4.04 The retrofitting of new dowels on the bars, and the cleaning, refacing and sealing of sawed longitudinal joints between contiguous lanes will not be measured for separate payment. This work shall be a subsidiary obligation under the pay item of Full Depth Joint Sawing.

508-4.05 Any undersealing of PCC pavement (Specification 502), full depth removal and replacement of PCC pavement (Specification 503), partial depth patching of PCC pavement (Specification 504), installation of new dowels (Specification 505) other than in full depth sawed joints, grinding of PCC pavement (Specification 506), and joint and crack sealing (Specification 507) other than for full depth sawed joints, ordered by the Engineer in lieu of pavement jacking, shall be measured for payment as provided in the respective specifications.

508-5 BASIS OF PAYMENT

508-5.01 The accepted quantity of injection holes, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for the drilling, cleaning, plugging and resealing of each hole as required by the plans and specifications.

508-5.02 The accepted quantity of bags of cement, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for furnishing all materials, hauling, mixing and injecting the jacking grout mix and the clean-up, as required by the plans and specifications.

508-5.03 The accepted quantity of full depth joint sawing, measured as provided above, will be paid for at the contract unit price. Such price and payment shall constitute full compensation for the sawing, retrofitting of dowel bars, refacing and sealing of the joints as required by the plans and specifications.

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508-5.04 Any pavement rehabilitation work items measured as provided in Article 508-4.05 above will be paid for under the respective pay items included in the contract. For such work for which no pay items are included in the contract, payment will be as provided for extra work in Article 104.04 of the General Provisions.

508-5.05 In addition to the above, payment under the unit prices listed below shall constitute full compensation for all materials, special monitoring devices, equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

508-5.06 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|---|-----------------|
| Pavement Jacking Injection Holes..... | Each |
| Jacking Grout – Cement..... (Grout Type _____) | Bag |
| Full Depth Joint Sawing..... | Linear Meter |

SPECIFICATION 509 – CRACKING, RESEATING AND RESURFACING OF PORTLAND CEMENT CONCRETE PAVEMENT

509-1 DESCRIPTION

509-1.01 Scope - This work shall consist of the controlled cracking of existing portland cement concrete pavement, the reseating, cleaning and patching of the cracked slabs, and the resurfacing with hot plant-mix bituminous pavement leveling, base and surface courses in accordance with these specifications and in conformity with the lines, grades and details shown on the plans or established by the Engineer.

509-2 MATERIALS

509-2.01 Bituminous tack coat material shall meet the applicable requirements of Specification 407 - Bituminous Tack Coat.

509-2.02 The bituminous plant mixes for pavement patching, leveling and surface courses shall conform to the requirements of Specification 401 - Hot Plant-Mix Bituminous Pavement.

509-2.03 Other materials required for this work shall conform to the provisions of the applicable specifications cited under Section 509-3 below.

509-3 CONSTRUCTION REQUIREMENTS

509-3.01 Protection of New Construction and Existing Structures

- a. All operations necessary for this work which might endanger or disturb any new construction to be performed under the project shall be completed before the new construction is begun.
- b. The cracking and reseating operations shall be performed in a manner that will not damage any existing structures which are to remain. Any damage to such

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structures caused by this work shall be repaired by the Contractor at his expense.

509-3.02 Construction Sequence - When the construction operations are limited to one lane in each direction at a time, the construction sequence shall provide for performing the cracking, seating and leveling course operations on the high side lanes first in order to facilitate the surface runoff during rainstorms.

a. Any existing bituminous mix overlays shall be removed from the PC concrete pavement until the concrete surface is exposed and any existing cracks are visible, prior to initiating the cracking operations.

b. The removed material shall be disposed of at the locations indicated on the plans. This material may be used for flattening slopes at selected locations when authorized by the Engineer. If no disposal locations within the project are indicated or authorized by the Engineer, then the Contractor shall dispose of the removed material, at his expense, at locations outside the project.

509-3.03 Pavement Drains - If the plans call for the installation of pavement drains, these shall be installed in conformance with the applicable requirements of Specification 501 prior to the pavement cracking operations.

509-3.04 Pavement Cracking

a. The cracking of the concrete pavement shall be done using hydraulic, pneumatic or gravity-type breakers, or other approved equipment, capable of producing controlled cracking to the required size and pattern, without displacing the concrete more than 1 centimeter vertically and without excessive spalling of the concrete. The hammer used shall provide a broad striking surface capable of cracking the

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concrete clearly without punching holes or disintegrating otherwise sound concrete.

b. The proper cracking technique shall result in fine hairline cracks that run vertically through the complete depth of the pavement slab. The desired pattern is for transverse cracks running the full width of the slabs at a nominal longitudinal spacing of 45 to 90 centimeters. Care shall be exercised to prevent the formation of continuous longitudinal cracks. The cracking shall result in cracked pieces with no dimension greater than 90 centimeters. The cracks shall be so fine as to require spraying water on the surface to render them visible to the eye.

c. Before cracking operations begin, the Engineer will designate one or more test sections about 30 meters long each, equivalent to 5 slabs. The Contractor shall crack the test sections pavements using varying energy and striking patterns until a satisfactory cracking pattern is established and is approved by the Engineer. The Contractor will be required to change his cracking equipment if he cannot obtain satisfactory results with his initial equipment in three consecutive test sections.

d. The approved energy and striking pattern shall be used for the remainder of the project unless the Engineer determines that a satisfactory cracking pattern is no longer being produced. Adjustments shall then be made to the energy and/or striking pattern as required to reestablish a satisfactory cracking pattern.

e. When cracking the test sections, the Contractor shall furnish and apply water toampen the pavement, following the cracking operations, to enhance the visual determination of the cracking pattern. During subsequent cracking operations, the Contractor shall furnish and apply water each day to one

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or more check sections, selected by the Engineer, to verify that the specified cracking pattern is being maintained.

f. The Contractor shall drill two cores in each test section, at his expense, to ascertain that the cracking is proceeding full depth and in accordance with the required pattern. The Engineer will select the location of these cores. After their inspection by the Engineer, the core holes shall be sealed with an approved grout mix at the Contractor's expense.

g. Cracking shall begin and end near a pavement joint. However, care shall be exercised with all cracking equipment when working near joints and edges to avoid spalling or undesirable crack formation. No impact blow should strike closer than 30 cm. to a pavement joint or edge.

h. Direct cracking over culverts, drainage pipes and other underground ducts located at a shallow depth below the pavement, as indicated in the plans, shall be avoided. No impact blow should strike closer than 1.5 meter to such structures.

i. Reinforced concrete bridge approach slabs shall not be cracked. If necessary, these will be jacked under Specification 508 - Jacking Portland Cement Concrete Pavement.

j. When cracking operations are performed adjacent to lanes on which traffic is being maintained, safety screens shall be provided by the Contractor to protect vehicles from flying chips during the fracturing process.

509-3.05 Reseating of Cracked Pavement

a. The reseating of the cracked pavement on the underlying base shall be done using heavy pneumatic tired

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rollers with suitable bodies for ballast loading to provide gross loads up to 50 tons. The rollers shall be chariot type meeting the requirements of proof rollers included in paragraph 203-3.06b of Specification 203 - Excavation and Embankment. Steel drum rollers and vibratory rollers shall not be used.

b. The cracked concrete pavement shall be rolled under a 50 ton load until the concrete pieces are securely seated and no vertical displacement is noted under the roller as it passes. A minimum of two roller passes over the entire cracked surface shall be provided.

c. No rolling shall be performed when extremely wet conditions in the subgrade would cause non-uniform or excessive movement during the rolling operation.

d. When lateral displacement or excessive deflection of the cracked pavement occurs, or adequate seating cannot be obtained by rolling as determined by the Engineer, the pavement will be removed.

e. The Contractor shall provide slab stabilization testing equipment meeting the requirements of Article 502-3.01 a. of Specification 502 - Undersealing of Portland Cement Concrete Pavement, and the personnel to operate it. The Contractor shall test for pavement deflections and evidence of loss of aggregate interlock under the supervision of and at the locations selected by the Engineer. Testing procedures shall be as provided in Article 502-3.02 of Specification 502, except that the limitation on testing hours will not apply.

f. Pavement removal and replacement shall be performed under the provisions of Specification 503 – Removal and Replacement of Portland Cement Concrete Pavement, modified as follows:

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1. The minimum polishing value requirement of the coarse aggregate as per Article 703-2.01, and the prohibition on the use of manufactured sands as per Article 703-1.02, included in Specification 703 - Aggregates, are not applicable to the replacement concrete pavement since it will not serve directly as a travel surface.
 2. No dowels or tie bars are required.
 3. No epoxy resin adhesive is required.
 4. Transverse dummy joints at 90 cm. spacing and staggered longitudinal dummy joints at 90 cm. spacing shall be provided in the new pavement to provide places of fracture in lieu of cracking. These joints may be sawed or formed and need not be sealed.
 5. No special surface texturing is required.
- g. In moving the rollers along the project during reseating operations, the ballast loads shall be reduced to insure the gross loads do not exceed the applicable weight limitations of any structures to be crossed.

509-3.06 Cleaning - After completing the reseating operations and prior to placing the bituminous mix leveling course, the pavement surface shall be thoroughly cleaned by power sweeping and air blowing with 100 psi nominal air pressure to remove all loose material which shall be disposed of by the Contractor at his expense. Any excess joint filler in the cracks and joints of the pavement shall be trimmed flush with the pavement as part of the cleaning operation.

509-3.07 Patching - Prior to placing the leveling course, all depressions and irregularities that will not be corrected by the leveling course shall be patched, as directed by the Engineer, using

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an L-1 or L-2 bituminous mix meeting the same requirements as the mix to be used in the leveling course over the cracked pavement.

509-3.08 Resurfacing Sequence

- a. The resurfacing sequence shall consist of the application of a bituminous tack coat and the laying of bituminous plant mix leveling, base and surface courses of the types and thicknesses indicated on the plans.
- b. The bituminous overlay shall be keyed into the existing PCC pavement at the ends of the project and at the connection with bridge approach slabs not to be resurfaced in accordance with the details shown on the plans. This work shall be a subsidiary obligation of the Contractor under bituminous plant-mix pay items.
- c. The longitudinal construction joints of the various bituminous pavement courses shall be offset not less than 15 cm. from the longitudinal joints in the underlying Portland cement concrete pavement.
- d. The construction sequence for the bituminous overlay shall provide for there being a difference of not more than one layer of thickness between adjacent layers at any time.

509-3.09 Leveling Course

- a. A leveling course of the mix type and minimum thickness specified on the plans shall be placed on the cleaned and patched (if required) cracked pavement to bring it to the proper grade and cross section in accordance with all the applicable requirements of Specification 401 - Hot Plant-Mix Bituminous Pavement, including the application of the required tack coat in conformance with Specification 407 - Bituminous Tack Coat.

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- b. The cleaning, patching and placing of the leveling course on each pavement section shall be completed within 5 days of performing the pavement cracking unless otherwise authorized by the Engineer.

509-3.10 Base and Surface Courses - The base and surface courses of the types and thicknesses specified on the plans shall be placed on the leveling course in accordance with the requirements of Specification 401 - Hot Plant-Mix Bituminous Pavement.

509-3.11 Traffic Control

- a. The Contractor shall provide for the maintenance and protection of traffic as specified in the contract documents, Specification 638 - Maintenance and Protection of Traffic, and the applicable articles of the General Provisions.
- b. Traffic may be allowed on the cracked pavement but no traffic shall be allowed on reseated and cleaned sections of pavement until a bituminous mix leveling course has been placed, unless specifically authorized by the Engineer.
- c. If for any reason, a pavement is opened to traffic after the cracking, reseating and cleaning operations but prior to placing the leveling course, the Contractor shall maintain, at his expense, the pavement for traffic by sweeping and patching as needed, except that the patching will be paid for as provided in this specification.

509-4 METHOD OF MEASUREMENT

509-4.01 The removal of existing bituminous overlays will be measured by the square meter of overlay removed to the satisfaction of the Engineer.

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509-4.02 Pavement cracking, reseating and cleaning will be measured by the square meter of existing concrete pavement acceptably cracked, reseated and cleaned.

509-4.03 The furnishing of all necessary testing equipment and personnel, and the performance of testing operations to determine pavement deflections after pavement cracking and rolling, will be measured by the number of days in which testing operations are performed. A test day is defined as any day in which testing operations, authorized and supervised by the Engineer, are performed regardless of the number of tests performed but not to exceed eight hours of testing operations.

509-4.04 Bituminous plant-mix material for patching and correcting irregularities, and hot plant-mix bituminous pavement leveling, base and surface courses will be measured by the ton used and accepted as provided in the contract and in Specification 401 - Hot Plant-Mix Bituminous Pavement.

509-4.05 Pavement drains will be measured by the linear meter as provided in Specification 501 - Portland Cement Concrete Pavement.

509-4.06 Any required removal and replacement of PCC pavement and related work items will be measured as provided in Specification 503 - Removal and Replacement of Portland Cement Concrete Pavement.

509-5 BASIS OF PAYMENT

509-5.01 Bituminous plant-mix pavement patching, leveling base and surface courses will be paid for under the pay items of Specification 401.

509-5.02 Pavement drains will be paid for under the pay item of Specification 501.

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509-5.03 Removal and replacement of PCC pavement and related work items such as excavation of unsuitable material, subbase and subgrade materials, and aggregate base course will be paid for under the respective pay items of Specification 503.

509-5.04 The accepted areas of bituminous overlay removed; of cracking, reseating and cleaning concrete pavement; and pavement deflection testing, measured as provided above, will be paid for at the contract unit prices. Such prices and payment shall constitute full compensation for all materials, labor, equipment, tools and incidentals necessary to complete the work as required by the plans and specifications.

509-5.05 Payment will be made under:

| <u>Pay Item</u> | <u>Pay Unit</u> |
|--|-----------------|
| Removal of Existing Bituminous Overlay..... | Square Meter |
| Cracking, Reseating and Cleaning Concrete Pavement..... | Square Meter |
| Pavement Deflection Testing..... | Test Day |

SPECIFICATION 510 - PORTLAND CEMENT CONCRETE PAVEMENT SMOOTHNESS

510-1 DESCRIPTION

510-1.01 Scope - This work shall consist in measuring the roughness for Portland Cement Concrete Pavement (PCCP) lots acceptance. The work shall be performed at the locations shown in the plans or indicated by the Engineer, in accordance with these specifications, and in conformance with the lines, grades and details shown on the plans or established by the Engineer.

- a. The Contractor will accomplish roughness tests during the construction process to evaluate the performed work and to ease the correction procedures.
- b. The Authority will perform the final measurements of surface roughness for the acceptance or rejection of the PCCP lots.

510-1.02 Equipment

- a. Pavement smoothness will be measured based upon the Profile Index (PI) as determined by the 25 feet computerized California type profilograph (non-uniformly spaced wheels), or a compatible device that correlates its results with the California type profilograph. The provided equipment shall comply with the ASTM E-1274, or the ASTM E-950 (Class I) in case the compatible device is selected. All pavement lanes and ramps shall be tested.
- b. The PI will be determined using the equipment's software. The PI units will be setup in inches per mile and will be carried out to one decimal point. The profilogram is the graph that presents the roughness profile and it will be recorded using a vertical scale of one inch equal one inch, or full scale, vertically. The equipment will be setup using a blanking band of 0.2 inches and a "must correct" bump or depression limit of 0.4 inches in a length of 25 feet for the purpose of the PI computations. Motive power may be manual or by a propulsion unit attached to the assembly. The

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equipment will be moved longitudinally at the right wheel path along the pavement, in the direction of traffic, at a speed no greater than 3 MPH.

c. A PCCP lots is defined as 528 feet (0.1 mile) of a pavement lane. It will begin or end with the equipment's measuring wheel at the abutment end wall or approach slab, at the change in pavement type, or at 528 feet (0.1-mile) pavement lot limit or fraction. For lanes with 12-feet width or less, the wheel path is located at 3 feet from and parallel to the right edge of pavement. For lanes with greater width than 12 feet, the profile will be taken on the right edge from the approximate lane marking. Manhole covers, drainage grates, pavement markings, signal detection slabs, and any other appurtenances in the wheel path will be included in the measurement of the profile index.

510-1.03 Surface and Tolerances Requirements

a. The Contractor shall furnish paving equipment and employ methods that produce a riding surface having a Profile Index (PI) within the acceptance zone presented in Table1. The equipment will be calibrated and operated by qualified technical personnel in compliance with the equipment's manufacturer recommendations and protocols. Initially, the Contractor shall provide a test section equivalent to three (3) lots for evaluation of the paving methods and equipment for smoothness purposes. Prior to the initial paving operations, or after a long shutdown period, the Contractor shall provide a test section for smoothness evaluation purposes. The smoothness evaluation will be done with the Contractor's equipment as soon as the curing process has been completed. After the initial pavement smoothness evaluation, if paving methods and paving equipment are acceptable to the Engineer, the Contractor may proceed with the paving operation.

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b. During the construction stages, the Contractor shall verify the PI every six (6) lots of production. The Contractor may submit correction proposal for those lots with PI falling in the penalties zone as stated in Table 1. The Authority may reject the Contractor's correction proposal and the PCC pavement lots will remain with the penalty. If the Authority accepts the correction to take place, the affected lot will be measured and a new PI established. No penalties will be applied to the Contractor until the final evaluation takes place. Lots with a PI falling in the rejected zone stated in Table 1, will be immediately removed and replaced, at the Contractor's expense prior to continuing the paving operation. All PI measurements will be handled to the Engineer and will be included in every monthly payment request.

c. The final smoothness evaluation will be measured with the Authority's profilograph. The profilograph will be calibrated and operated by qualified technical personnel in conformance with the profilograph manufacturer recommendations and protocols. During testing operations, it will be the Contractor's responsibility to provide traffic control, as it will be to furnish survey services and reference points tied to the stationing system of the project. No compensation will be provided for these services.

d. The acceptance criteria will be in conformance with Table 1. On roadway lots less than 528 feet in length, the penalties will be reduced proportionally with the actual length of the lot. Segments shorter than 15 feet will not be considered for penalties.

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PAVEMENT SMOOTHNESS**

**Table 1
Acceptance Criteria for PCC Pavements Lots**

| Type of Facility | Acceptance | | | | Rejected | |
|--|------------|---------|--------------------------|--|----------|--------------------|
| | PI | Penalty | PI | Penalty | PI | Penalty |
| New Construction or Rehabilitation Project | < 15 | None | $15 \leq \text{PI} < 40$ | Penalty of \$200 per every PI above 15 | > 40 | Remove and replace |