DIVISION 500
Concrete Pavement

SOUTH CAROLINA
DEPARTMENT
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Section 501
Portland Cement Concrete Pavement

501.1 DESCRIPTION OF WORK

The performance of Portland cement concrete (PCC) pavement depends primarily on design adequacy, the quality of materials used in the work and the quality achieved during production, placement, consolidation, finishing and curing of the PCC mixture. Misunderstood or misapplied specifications or the use of poor construction techniques and improper equipment operation can greatly affect pavement quality. PCC pavement construction is a highly mechanized operation that requires continual inspection of work and materials and a working knowledge of numerous types of equipment. The Resident Construction Engineer and SCDOT Inspectors should become thoroughly familiar with the material, equipment and construction requirements of the Contract Plans and Specifications.

501.2 CONCRETE QC / QA CONSIDERATIONS

The Contractor is responsible for developing a quality control plan that establishes the personnel, methods and procedures that will be used during the project to control the quality of work and materials. The plan must be consistent with the QC / QA requirements specified in the Contract. The minimum level of Quality Control Samples and Tests are presented in Section 106. The quality control plan will usually be reviewed with the Resident Construction Engineer and Research and Materials Engineer at the Preconstruction Conference or pre-paving meeting, if required. Do not permit the Contractor to begin work until the quality control plan has been discussed and agreed upon. During construction, observe that the Contractor operates in accordance with the plan. A Batch Plant Technician, delivery tickets or SCDOT Form 700.04 – Ready Mix Concrete Report are not usually required when a dedicated central-mix plant is used to produce concrete exclusively for the paving project. Unless otherwise specified, the Research and Materials Laboratory will furnish the molds and test equipment for the field laboratory to perform flexural testing of the required concrete beam specimens. See Section 701.2 for additional information pertaining to concrete QC / QA.

501.3 PCC MIX MATERIALS

Many materials used on PCC pavement construction projects are supplied from pre-approved sources. SCDOT Inspectors will be responsible for ensuring that materials required for PCC pavement construction are supplied from sources listed on the following Approval Sheets:

- Approval Sheet 1 – Fine Aggregate Sources for Concrete,
- Approval Sheet 2 – Coarse Aggregate Sources,
- Approval Sheet 3 – Fly Ash for Portland Cement Concrete,

- Approval Sheet 5 – Chemical Admixtures and Air Entrainment Agents for Concrete,
- Approval Sheet 6 – Authorized Portland Cement and Non-Steel Slag Manufacturers,
- Approval Sheet 8 – Silicone Sealants for Portland Cement Concrete Pavement Joints,
- Approval Sheet 18 – Authorized Type I (SM) Slag-Modified Portland Cement Manufacturers,
- Approval Sheet 28 – Ready-Mix Concrete Plants Inspected by SCDOT,
- Approval Sheet 32 – Stabilizer Agents for Mixer Drum Wash Water, and
- Approval Sheet 33 – Curing Compound for Concrete Structures.

In addition, on reconstruction projects, the Contract Plans may allow PCC pavement recycling. The pavement generally will be broken in place, crushed and screened. The resulting aggregate material then will be reused in the new PCC mixture. Existing reinforcing steel, HMA overlay material, joint sealant, and other foreign materials, if present, will be removed and disposed of properly to minimize contamination of the recycled aggregate material. Where used, observe the breaking operation for extensive disturbance of the underlying subgrade or base material. Such disturbance may require reworking of the subgrade or base. The SCDOT Inspector will obtain all cementitious samples with Mill Test Reports in accordance with the frequency defined in Section 106. Plant Technicians need to ensure that materials used in the mix are from the same source as in the approved mix design. The Contractor will be responsible for notifying the Resident Construction Engineer prior to any desired change in material sources for the PCC mixture. Such changes will require the Contractor to submit a new Mix Design for review by the Research and Materials Engineer. See Section 701.2.4 for additional information on PCC mix materials.

501.4 PCC PAVEMENT MATERIALS

501.4.1 Tie Bars

Ties bars are never coated with wax or grease during installation. Tie bars are typically used on longitudinal construction joints and other locations where the two slabs are not intended to move independently. Tie bars must develop a bond with the concrete, which is why deformed steel bars are used. Where used, tie bars will be deformed steel bars conforming to the Contract Specifications. Verify that the tie bars are the proper size, length and grade.

501.4.2 Dowel Bars

Dowel bars are typically used on transverse construction joints and other locations where the two slabs are intended to move horizontally independent of each other. Dowel bars will be plain, round bars conforming to the criteria specified in the Contract. Verify that they are delivered in a smooth condition. It is preferred that dowel bars be coated with an acceptable waxy material applied at the fabrication facility, however, the Contractor may be allowed to apply by hand an acceptable grease just prior to installation. The purpose of this coating is to

break the bond between the steel and the concrete, which is important for the device to serve its intended function. The Contractor must indicate the method of coating prior to initiating work. Contact the Pavement Systems Manager at the Research and Materials Laboratory if there is any doubt regarding compliance of the coating material. When the coating is applied by hand, pay particular attention to how the grease is applied. It should be applied around the entire circumference of the dowel, not just to the top of the dowel prior to installation, which is a poor construction shortcut. The hand-applied coating should be a light, uniform coating with a minimal number of large globs, because such globs tend to dry out and cause voids to develop next to the dowel. These are primary reasons why factory-applied coatings are preferred.

501.4.3 Curing Materials

See Section 702.2.5.5 for information on curing materials.

501.4.4 Joint Sealant Materials

See Section 702.2.5.4 for information on joint sealant materials.

501.5 PCC MIX PRODUCTION AND HAULING

Upon preliminary approval, the proposed Mix Design will be used to produce an initial trial batch, which will be sampled and tested for 14-day flexural strength as well as properties as discussed in Section 701.2.6. Section 106 documents the Quality Control Samples and Tests and Independent Assurance Samples and Tests required to monitor PCC mix properties (e.g., slump, air content, test cylinders, flexural beams). Unless otherwise directed, SCDOT Inspectors, as assigned, will sample and test the PCC mixture during production, including the preparation of test beams for flexural strength testing. The test specimens will be molded and cured in accordance with SC-T-46 (see Appendix C). The Resident Construction Engineer will use the results of testing these specimens to determine compliance of 14-day flexural strength and the need for any mix adjustment, replacement of concrete or acceptance with a reduced pay factor. See Section 701 for additional information on PCC mix production and hauling considerations.

501.6 PCC PAVEMENT CONSTRUCTION

501.6.1 Preconstruction Conference

A Preconstruction Conference (see Section 108.2) will be held prior to starting each SCDOT construction project. The purpose of this Conference is to ensure that a working understanding is established among all parties involved in the project, thus enhancing coordination and reducing miscommunication and delays. The Conference will establish an overall cooperative tone and ensure that all parties involved understand the project and are ready for production work. In general, attendees should include the Research and Materials Engineer, Resident Construction Engineer, SCDOT Inspectors, Contractor Superintendent, Batch Plant Inspector,

Concrete QC / QA Technicians and other key personnel to discuss contractual items such as scope of work, scheduling requirements, project meetings, quality control, mix design, placement method, maintenance of traffic, job safety and any special requirements of the project. Key pay items in the Contract should be discussed so that all affected parties will understand the schedule, materials, construction methods, sampling and testing responsibilities, acceptance criteria and method of measurement and payment.

501.6.2 Communications During Production and Paving

During the project, quality and safety depend on continued positive and meaningful communication between the Research and Materials Engineer, Resident Construction Engineer, Roadway Inspectors, Batch Plant Inspector, if applicable, and Concrete QC/QA Technicians. Frequent informal meetings provide a forum for meaningful dialog to mitigate potential cost and scheduling problems. In addition, frequent communications between plant and roadway personnel provides critical feedback to ensure that a quality pavement is being produced, especially when adjustments to the mix design are needed. Key points of discussion should be noted in the Daily Work Report.

501.6.3 Safety Considerations

Job safety at both the PCC production facility and the paving site cannot be overemphasized. Both SCDOT and Contractor personnel must continually practice safe working habits. OSHA regulations must be understood and followed by all personnel. Each person should clearly understand what is expected of them and how to perform their assigned tasks. Dust, noise, haul trucks, pavers and traffic moving through the work area all pose potential hazards. New personnel should be properly instructed, and seasoned personnel should not become careless. Constant care and vigilance are needed to prevent accidents and injury. It is wise to periodically remind personnel that they are operating in a potentially dangerous environment. If an unsafe work practice is observed, corrective action should be taken immediately, even if the operation must be delayed. See Section 107 for additional information.

501.6.4 PCC Paving Equipment

The Resident Construction Engineer and SCDOT Inspectors will be responsible for inspecting the following PCC pavement construction equipment:

- subbase planer;
- slip-form paver, forms and concrete spreaders, as applicable;
- finishing machine, vibrators, tube finishers and hand tools;
- transverse groover;
- equipment used to apply curing materials;
- equipment used to apply material for rain protection;
- concrete saws used for cutting joints; and
- equipment used to heat and apply joint filler and sealants.

Slip-form paving is typically used on SCDOT PCC paving projects. The use of stationary forms and other concrete placement methods may be necessary for irregular areas along the project, but requires prior approval of the Resident Construction Engineer. Use the following guidelines when inspecting PCC paving equipment:

1. Type. Verify that the Contractor has provided the type of equipment required for the project. It is recommended that manufacturer's brochures of the equipment be obtained from the Contractor and reviewed prior to initiating paving.

2. Capacity and Number. Verify that the equipment provided on the project is sufficient, in terms of capacity and number, to perform the work in a continuous and timely manner.

3. Condition. Check that the Contractor maintains equipment in good working condition and has sufficient spare parts and backup equipment on-hand to minimize unnecessary delays due to mechanical breakdown. This is especially important for concrete saws.

4. Calibration. For construction equipment that requires calibration before use, such as the slip-form paver, ensure that the equipment is properly set to meet specified results and perform periodic inspections, as needed, to determine if recalibration is necessary.

5. Operators. Although the equipment may be acceptable, the use of inexperienced operators can often lead to unacceptable results. Where this matter is suspected, discuss this situation with the Resident Construction Engineer and, as needed, direct the Contractor Superintendent to provide an experienced operator.

501.6.5 PCC Paving Limitations and Pavement Protection

Normally, the mixing and placement of concrete should be conducted only when the ambient temperature is within specified limits. Refer to the Contract Specifications for temperature restrictions. In addition, check that the Contractor has sufficient material on hand to protect exposed surfaces of unhardened concrete from rain. The washing effect of sudden showers and downpours will remove the cement paste from fresh concrete surfaces. If rain is imminent, the Contractor should cease mixing, paving and finishing operations and immediately cover the exposed unhardened surface. Under such cases, the Contractor still must finish the surface of the freshly poured concrete. This may be accomplished as follows:

1. Brief Showers. If the shower is brief, the Contractor may completely remove the protective covering after it rains and then finish the surface.

2. Continuous Showers. For continuous showers, the Contractor must repeatedly roll back the protective covering approximately 3 feet at a time to finish the surface and replace the covering without marring the finished surface.

As soon as practical, inspect the surface for defects, and immediately inform the Contractor of any needed repairs. Note your findings and directives to the Contractor in the Daily Work Report. In addition, the edges and the surface must be protected against damage from vehicular traffic and construction equipment. The edges of slabs in areas where traffic is permitted to cross new pavement prior to shoulder construction are especially susceptible to

damage. Wood blocking, for example, may be used along the edge of the slab to minimize potential damage from cross traffic. Visually inspect edges prior to acceptance, and ensure that the Contractor repairs any damage.

501.6.6 Subbase and Base Course Construction

A PCC pavement generally requires the construction of a base course, primarily to prevent the erosion of the subgrade by the pumping action of concrete slabs, which can lead to premature pavement failure. The Contract Plans and Specifications will designate the type of base course and subbase, if required, to be constructed over the subgrade. It is important that the construction of underlying layers be carefully constructed, including removal of soft spots, installation of drainage facilities, compaction to target density, trimming to grade and cross-section and protection from rutting and damage. The use of scratch planers with spikes or teeth is not permitted. The subgrade, subbase and base course will require progressive approval by the District Construction Engineer. Pay attention to the grade and compaction of the area beyond the edge of paving, because it will be used either as a wheel track for the slip-form paver or as the foundation for fixed forms. Do not allow construction vehicles to traverse this area. Undulations in the grade and settlement of the forms will invariably be reflected in the surface of the PCC pavement. Unless a waterproof base material is used, the grade must be kept uniformly moist at the time concrete is placed. Verify that the base is sprinkled sufficiently ahead of the paving train to keep the material moist without ponding water. See Division 300 for additional information on pavement structures and subgrade, subbase and base course construction.

501.6.7 Placement of Reinforcing Steel

Ensure that dowel bars and tie bars are placed in accordance with the dimensions and provisions of the Contract Plans and Specifications. Ensure that dowels are of the correct size and length. Note that, although required for dowel bars, grease or wax must not be applied to tie bars. Check load transfer devices to ensure that they are correctly located, within tolerance, firmly fastened, properly lubricated and that the shipping braces have been cut, where applicable. Ensure that joint locations are properly and accurately marked for the saw crew.

501.6.8 Concrete Delivery

If appropriate, document on SCDOT Form 700.04 – Ready Mix Concrete Report the quantity of water or admixture added to the concrete, check that the water-cement ratio has not been exceeded and ensure that the truck mixer uses the correct number of revolutions prior to discharging the mixture. Check and record compliance of concrete and air temperature. Regardless of the construction method used, the concrete must be placed so that a minimum of rehandling is necessary. Verify that footprints in fresh concrete are vibrated, and check for signs of segregation. Serious segregation is grounds for rejection. Check slump for compliance with the construction method being used. Concrete consistency should be similar from load to load. Pay attention to compliance of the elapsed time of concrete delivery from the time water was introduced to the cement. Observe the discharge operation for complete removal of the batch from the truck. This is especially important if non-agitating trucks are used.

501.6.9 Slip-Form Paving

Slip-form paving is typically used for SCDOT PCC paving projects. The Resident Construction Engineer, however, may permit fixed-form, lane-by-lane construction on variable width, small or otherwise restricted sections. The slip-form paving train is designed to spread, consolidate, screed, float-finish and texture concrete and place curing material in a single pass. The primary components of the slip-form paver include auger spreader, spud vibrators, oscillating screeds, tamping bars, pan floats and sliding forms. The rigid sliding forms on either side of the paver progressively form the concrete slab. The screeds roll excess concrete in a forward direction to fill low spots. Concrete distribution and consistency are extremely critical, because non-uniform distribution and piles of “dry” concrete will cause the paver to float above true grade, resulting in surface undulations. To ensure pavement smoothness, it is critical that excess concrete ahead of screeds be sufficiently small to allow rolling rather than shoving. Consider the following:

1. Line and Grade. Verify proper adjustment of the sensitivity of the feeler sensors and the tightness of the guide wire to ensure that adequate control of line and grade will be maintained. It is good practice to periodically walk ahead of the paver to check that the wheel-track path is in a smooth condition and that the guide wire is taut without measurable sag. Irregularities will be reflected in the finished surface.

2. Dowel Assemblies. Haul trucks are generally used to place concrete on dowel assemblies immediately ahead of the paver. Verify that the haul trucks operate away from the wheel-track path of the paver and that placement of the concrete does not displace the dowel assemblies.

3. Screeds. Check screeds with a stringline to ensure proper cross-section.

4. Vibrators. Verify the type and number of vibrators are adequate for proper consolidation across the full width and depth of the slab. Check compliance of vibrator frequency using a tachometer or verify the vibration frequency on the paver console, if so equipped.

5. Paver Speed. As practical, the slip-form paver should be operated in a continuous forward motion at a speed that is coordinated with production and delivery. If the paver must be stopped, verify that all vibratory and tamping elements are turned off.

6. Slump. Check compliance of concrete slump. Slump should be low enough to allow concrete to roll in front of the screed, but stiff enough to prevent appreciable edge slumping. Pay particular attention to edge slumping along longitudinal joints.

7. Hand Redistribution. If operated properly, minimal hand redistribution will be necessary. As practical, limit handwork and advise the Contractor to adjust the operation.

501.6.10 Fixed-Form Paving

501.6.10.1 Forms

Fixed forms are generally used where slip-form paving is not practical. Forms that are used in fixed-form paving serve as a track for paving equipment, laterally support the concrete slab and establish the profile and alignment of the pavement. They must be set properly and sufficiently in advance of paving to promote the development of a quality riding surface in a continuous operation. Verify compliance of form type, number, dimension and condition. Straight forms will be used on tangent sections, and flexible forms will be used on curved sections. The use of battered forms is not permitted.

501.6.10.2 Form Setting and Removal

Improper setting of forms will create unacceptable undulations in the final pavement surface. The entire length of each form must be firmly seated on a compacted base that is true to grade. It is preferable to trim a higher base than to bring low spots up to grade in compacted lifts. Forms must be capable of withstanding vibrations and the load of finishing equipment. Settlement of forms under the load of paving equipment is a major source of surface undulations. Settlement or springing of forms is unacceptable. Check that the forms are tightly secured and free from play or movement. Require resetting where excessive movement is observed. Sight along the top of forms and use a stringline to check for grade undulations and obvious irregularities in alignment. Measure the width between forms for compliance. The base should be wetted and the forms cleaned and oiled well ahead of paving, then the base re-sprinkled just ahead of concrete placement. This is essential to prevent loss of moisture from the concrete into the base. Watch for ponding of water. Note that wetting of the base may not be necessary if a waterproof base course has been constructed. Forms should generally not be removed until the concrete has set for at least 8 hours. Once removed, check for honeycombed or damaged areas and verify the immediate application of curing compound to the horizontal and vertical surfaces of the slabs.

501.6.10.3 Concrete Placement

Concrete will be placed between the forms and between transverse joints ahead of the spreader. The use of intermediate bulkheads between transverse joints is generally unacceptable. Verify that the concrete is discharged from the container while it is moving away from the spreader. Concrete that is “dumped” in piles promotes segregation, causes non-uniformity, increases strain on the spreader and requires unnecessary hand redistribution. Where hand redistribution is necessary, it must be performed with shovels, not rakes. Do not permit construction personnel to walk through fresh concrete with boots caked with dirt or mud, and verify that footprints are properly vibrated. Minimal handwork should be needed.

501.6.10.4 Concrete Spreading

The mechanical spreader is a self-propelled machine equipped with a screw or plow type device to distribute the concrete between the forms, an adjustable screed to strike-off the concrete,

internal vibrators to consolidate pavement edges and a vibrating pan or other system to consolidate the concrete. The function of the spreader is to distribute and strike-off the proper amount of concrete for finishing, to consolidate the edges and prevent honeycombing and to perform initial consolidation of the concrete slab. The bottom elevation of the distributor and the strike-off assembly will be adjustable. When checking the adjustment of the spreader, the strike-off should be set level with the top of the forms at which time the gauge should read zero. The strike-off then should be adjusted for proper thickness. Finally, the distribution device should be adjusted so that a small uniform quantity of concrete is rolled in front of the strike-off screed. Low areas in front of the screed should be filled with concrete from the mixer. Mortar is not to be used for this purpose.

501.6.10.5 Transverse Finishing

The transverse finishing machine is equipped with two transverse screeds. The purpose of this machine is to make the surface of the fresh concrete conform to the final profile and cross-section. It should be used to cut and drift material as necessary and should never leave such work for the final finishing float. Two passes of the finishing machine are usually adequate to tamp and shape the pavement surface. The number of passes necessary can be judged by observing the uniformity of the roll or excess mix carried on the rear screed. The front screed should always carry against it a uniform roll of concrete the full width of the pavement, a heavy wave being carried the first time over and lighter waves on each successive trip. The rear screed should be pushing a 2- to 3-inch roll over the entire width on the final pass, using shovelers to work the material manually to the high side, where necessary. Generally the front screed is set slightly higher than the one in the rear. If the rear screed is not pushing the required roll of mortar, it indicates the front screed is set too low. On the high sides of superelevated curves, the concrete must not be permitted to slough away from the forms. The finishing machine should be equipped with adequately maintained scrapers at each wheel to prevent intrusion of mix between them and the top of the forms. Verify that the top of forms are kept free of accumulated material and that the screed wearing plates which ride on the forms are not excessively worn. Use the following procedures to check screed adjustment:

- center the screed and lift off forms;
- stretch fine wires taut between the forms at the front and back of each screed;
- place blocks of uniform thickness on top of the wires at each form; and
- lower the screeds.

The proper crown is placed in the screed by measuring between the taut wire and the face of the screed and adjusting the hanger bolts. The front screed should be tilted with the front edge slightly higher. The rear screed should be set flat or with a tilt not exceeding specified tolerance. Where two finishing machines are used, the screeds on the rear machine should have little or no tilt.

501.6.10.6 Float Finishing

Float finishers, in general, greatly affect the finished surface because they correct irregularities that are left by proceeding operations. Therefore, adjustment of the float finisher is extremely

critical. During the following procedures, the longitudinal float finisher should be loaded with approximately the same weight, including the operator, that it will carry during operation. Verify the alignment of the float along its centerline and both edges as follows:

- Check the height of the transfer tracks that carry the float assembly, at the front and the rear of the machine, to ensure that all four ends are equidistant from the horizontal plane formed by the bottom of the wheels.

- Place taut wires across the top of the forms and verify that the tracks are adjusted to conform to the desired cross-section of the finished surface.

- Stretch two wires across the top of the forms at a distance apart equal to the length of the float. When the float is lowered, all four corners of the float should be the same distance from the wires at a distance equal to the ordinate of the desired cross-section.

To ensure proper operation after alignment, verify that the scrapers are in good condition and in solid contact with the flanged wheels or forms at all times. It is unacceptable for the operator to adjust the float to compensate for either a surplus or a deficit of concrete.

The transverse float finisher is an acceptable alternative to the longitudinal float finisher. The transverse float finisher is carried on a long wheel base frame that rides on the forms and finishes the concrete with transverse oscillating screeds and a stationary float. The front screed normally rides on the forms and may be checked in a similar manner to that described for the transverse finishing machine. The second screed and the float do not ride on the forms but are suspended from the frame; therefore, their elevation is much less affected by form irregularities. Check that both screeds and the float are adjusted to the proposed cross-section. When in the down position, verify that the ends of the screeds and the float are set about the same elevation as the top of the forms. Once the operation is started, it is acceptable to make small final adjustments to match the desired cross-section and proper surface finish.

501.6.11 Concrete Consolidation

Consolidation subsides plastic concrete while filling internal voids and removing entrapped air, not entrained air. If the concrete is not adequately vibrated, an excessive quantity of entrapped air will remain and optimum consolidation will not be achieved. Overconsolidating, however, is highly undesirable, because it removes entrained air, segregates component materials and leaves a layer of low-strength mortar on the pavement surface. In both slip-form and fixed-form paving methods, mechanical vibrators of different types are used to consolidate the plastic concrete as it is placed. Vibrators are typically attached to the back of the spreader, the front of the finishing machine or on a separate piece of equipment. The vibrators will be either the surface type (e.g., screed, pan) or the internal type (e.g., immersed tube, gang-mounted spuds) and will be mounted in such a manner that they will not come into contact with reinforcing steel, joint assemblies, forms, subgrade or base course. However, the entire width of the pavement must be vibrated to adequately consolidate the slab throughout the full depth of the plastic concrete. Hand-operated vibrators will also be used. Consider the following guidelines:

1.

Abutting Slabs / Forms. Special attention must be given to properly consolidate concrete along the face of abutting slabs and side forms. Visually check that these areas are properly consolidated with hand-operated vibrators without contacting the forms.

2. Load Transfer Devices / Joint Assemblies. Hand-operated vibrators must be used to consolidate concrete near load transfer devices and joint assemblies. Ensure that this operation does not displace the devices or overconsolidate the concrete.

3. Overconsolidation. Vibrators must be kept moving and not held in one location for more than 15 seconds. Do not permit equipment-mounted vibrators to be operated when the equipment is stopped.

4. Frequency / Amplitude. Many paving machines have direct electronic indicators of vibrator frequency on the instrument panel. For older machines, the Contractor should have a reed tachometer capable of directly displaying the vibrator frequency. Vibrator frequencies should be checked at the start of paving and anytime inadequate consolidation is suspected. Check the frequency of vibrators often for compliance using the tachometer. See the Contract Specifications for frequency and amplitude requirements.

5. Working Radius. Spud vibrators typically have an effective working radius of between 5 to 10 inches, depending on their diameter, amplitude and frequency. For practicality, spud vibrators should achieve an effective consolidation radius of approximately 9 inches. In general, the higher the frequency, the better the consolidation.

6. Surcharge. Spud vibrators must not be drowned in an excessive surcharge of concrete. The surcharge should generally not exceed 6 to 8 inches.

7. Speed of Travel vs. Consolidation. The equipment speed greatly affects the length of time that gang-mounted vibrators influence the plastic concrete. In general, the speed of travel should be 12 feet per minute or less. A maximum vibrator spacing of 24 inches will generally require less than 10 feet per minute of forward travel, and a maximum spacing of 18 inches will require a speed of 10 to 20 feet per minute.

501.6.12 Surface Correction and Finishing

After the floating operation is complete and while the concrete is still in its plastic state, any excess water should be removed from the surface using a 10-foot straightedge and the surface tested for trueness in the prescribed manner. If high or low spots are found, concrete will be added or removed and the area refinished and rechecked. Pay particular attention to the surface elevation across joints. The straightedge used for testing should not be used for finishing concrete. Checking of the surface must continue until it is free of irregularities. The addition of water to the surface for the purpose of finishing will not be permitted, because it weakens the pavement's surface. However, a fog spray may be approved to assist in curing and, if permitted, will be strictly controlled. Prior to the concrete taking its initial set, the edges at forms and joints will be worked as specified. The final surface texture will be produced using either a burlap or turf drag or transverse groover to provide a non-skid surface. Refer to the

provisions of the Contract for the specified finish. If a burlap or turf drag is used, the final texture will be produced by dragging wet burlap over the surface as many times as necessary to produce the desired results. The burlap must be maintained in a moistened and clean condition at all times. Where a transverse groover is used, check the tining for proper size, shape and depth. The tines must be maintained at the proper tension, spacing and cleanliness to produce the proper finish. As specified, verify that project stationing is being stamped into the pavement at the correct locations. If rumble strips are designated, ensure that they are placed at the proper time, location, size, shape and depth and that they do not interfere with joints or ramps.

501.6.13 Joint Construction

Ensure that joints are constructed in accordance with the dimensions, methods and provisions specified in the Contract Plans and Specifications. Consider the following:

1. Longitudinal Construction Joints. Check that longitudinal construction joints are properly located with respect to lane lines. Check the installation of keyways for compliance. Where tie bars are installed, check that they are of the correct type, grade, size and length. Verify that they are inserted by approved methods ahead of vibrators and at the proper location and spacing.

2. Longitudinal Weakened Plane Joints. Check that longitudinal weakened plane joints are properly located with respect to lane lines. Where tie bars are installed, check that they are of the correct type, grade, size and length. Verify that they are inserted by approved methods ahead of vibrators and at the proper location, depth and spacing.

3. Transverse Weakened Plane Joints. Check that transverse weakened plane joints are properly located and constructed with respect to load transfer devices and joints in adjacent widening and shoulders.

4. Expansion Joints. Ensure that preformed joint filler material is properly placed at all structures, manholes, inlets and other projections into the pavement.

It is critical that sawing of joints be performed before random cracking of the concrete starts, even if the operation must be performed at night. The Contractor should have one or more backup saws in case of failure.

Transverse joints, because of their function to relieve early shrinkage stress within the pavement, must be cut as soon as the concrete has hardened enough to support the saw equipment without excessive raveling of the cut. Some raveling of green concrete should be expected when sawing joints, which can be considered a rough guide to govern the time at which sawing of joints should begin. Require immediate correction of the operation if excessive raveling occurs during sawing. If a sharp edge joint is being obtained on control cutting, it can generally be regarded that the concrete has hardened excessively and sawing is being conducted late. Verify that joints are centered over load transfer devices.

501.6.14 Concrete Curing

The most commonly used curing method is spray-on, white-pigmented curing membrane (clear curing membranes are not allowed on pavements). The purpose of applying this membrane to the surface is to maintain the cement in a hydrated state while the concrete cures after its initial set. If water is allowed to evaporate too quickly, it will damage the pavement, causing hairline cracking and a weak surface that has little resistance to traffic abrasion. The curing membrane should be applied when the surface is still moist, but absent of free water. Verify that the curing membrane is listed on SCDOT Approval Sheet 33 and applied at the proper time. The curing compound will be applied with spraying equipment that can apply a smooth, even-textured coating. During windy conditions, it will be difficult to apply such a coating. Ironically, this condition is when the curing membrane is needed most, because the wind and sun combination promotes accelerated evaporation. Verify the rate of application of the curing compound and watch for areas that are not uniformly coated. When side forms are removed, the sides of the slab are to be cured in the same manner. This applies to slip-form paving too. Upon form removal, ensure that the curing compound is applied without delay. If the curing membrane is damaged by rain, verify proper reapplication of the material.

501.6.15 Joint Sealing

Prior to cleaning and sealing of concrete pavement joints, verify that the joint reservoir dimensions (i.e., depth and width of the final saw cut) are in accordance with the Contract Plans. If the actual dimensions do not conform to those shown on the Plans, contact the Pavement Design Engineer prior to beginning the sealing of the joints.

501.6.15.1 Silicone Sealant

Silicone sealant should not be applied until the new concrete pavement has cured a minimum of 7 full days; longer times are preferred. Sealant should not be applied when the temperature is below 45°F. Final cleaning of the joint, installation of the backer rod and application of the sealant must be performed on the same day. Prior to installing the backer rod and the joint sealant, it is essential that the joint surface be clean and dry. Solvents must not be used in the cleaning process. Sandblasting is the preferred method of cleaning. Sandblasting should be performed in two passes, one pass for each joint face. During this operation, the nozzle should be no more than 2 inches from the face of the joint. One pass of a high-pressure air blast is then necessary to remove any residual dust and sand. The Contractor cannot begin sealing the joints until the SCDOT Inspector approves the cleaning of the joint reservoir. Prior to installing the backer rod, rub your finger across the joint face to verify that it is both clean and dry. If any dust shows on your finger, do not allow sealant to be placed until the joint is adequately cleaned.

After the joint faces have been properly cleaned, backer rod shall be installed as per the Contract Plans. Ensure that the backer rod is installed to the manufacturer's recommendations and not stretched during installation. The backer rod should fit firmly in the joint reservoir. Verify the proper installation depth of the backer rod. This depth is critical to the performance of the sealant. Sealant should not be applied if the face of the joint is not clean and dry. The

sealant shall be applied in a continuous operation to properly fill the joint; stopping and starting is not permitted. The sealant should be recessed 0.25 inch from the concrete surface, with any excess being removed from the pavement surface. If tooling of the silicone is required, it should be performed within 10 minutes of application. Resealed joints may be reopened to traffic when the silicone sealant reaches a tack-free condition. This condition is typically reached in approximately 60 minutes, depending on temperature and humidity.

501.6.15.2 Neoprene Sealant

Neoprene sealant should not be installed until the new concrete pavement has cured a minimum of 7 full days; longer times are preferred. Sealant should not be installed when the temperature is below 45°F, nor when the temperature is above 85°F. Final cleaning of the joint and installation of the neoprene sealant must be performed on the same day.

Prior to installing the neoprene sealant, it is essential that the joint surface be reasonably clean and dry. The joint should be air-blasted to remove any debris. The Contractor cannot begin sealing the joints until the SCDOT Inspector approves the cleaning of the joint reservoir. Care should be taken during the installation process to ensure that the neoprene is not stretched. This can be done by comparing the distance between two marks on the seal measured before and after installation. The SCDOT Inspector should also ensure that the neoprene has not been twisted or damaged, and is recessed in accordance with the Contract Plans. Splicing of the material should not be permitted without the prior approval of the Pavement Design Engineer, and should be performed in accordance with the neoprene supplier's instructions.

501.6.15.3 Hot-poured Rubber-Asphalt Sealant

Procedures for cleaning and preparing the joint prior to sealing are the same as for the silicone sealant. However, sealant dimensions may vary from those used for silicone, and the backer rod must be of the type capable of withstanding the high sealant temperatures. Ensure that the kettles used for melting the sealant are operating at a temperature within the specification requirements. Sealant is placed at a high temperature; care should be exercised to avoid contact with the hot sealant.

501.6.16 <u>Pavement Thickness Determination</u>

The provisions of the Contract will require the pavement to be cored at specified intervals so that the slab thickness can be determined by caliper measurement. Calipers may be obtained from the Research and Materials Laboratory. Slab thickness should be determined as soon as a sufficient length of pavement has been poured and reached adequate strength to support the coring equipment. Unless otherwise specified, the Contractor will perform this task with oversight by SCDOT Inspectors at locations specified by the Resident Construction Engineer. Measure and document in the Daily Work Report the location and results of thickness coring testing. If the measurement or average of measurements is less than the thickness specified in the Contract Plans, the area of pavement represented by the deficient cores will be either accepted, replaced or subject to a reduced payment depending on the severity of the deficiency.

Ensure that coring is performed to miss tie bars, dowels and other embedded items and is no closer than 2 feet from joints. Ensure that all cored locations are backfilled with PCC mix or an approved grout material.

501.6.17 Pavement Rideability

The following factors are primary contributors to roughness of the final PCC pavement surface:

1. Concrete Mix. Inconsistent concrete mix properties may change the hydraulic forces acting on the paver and on the final pavement profile.

2. Guide Wire Sags. The paver guide wire must be set at the proper profile and kept taut. Sags in the guide wire will invariably be reflected as undulations in the pavement surface. The use of high-tension aircraft cable is recommended to reduce sags in the line. It is also recommended that that the guide wire supports be spaced at no more than 25-foot intervals. All construction personnel must pay particular attention to avoid brushing or snagging this line.

3. Frequent Starts and Stops. Frequent stopping and starting of the paver may result in roughness in the pavement surface. The Contractor should provide sufficient trucks to keep the paver continuously charged and moving under normal circumstances. The Contractor should keep the paver moving as much as possible. If it is necessary to stop the paver, ensure that all vibrators are also stopped.

4. Excessive Hand Finishing. Excessive hand finishing tends to create roughness in the final pavement surface. If repeated hand finishing is observed, adjustments in the Mix Design may be needed to ensure a workable concrete mixture.

The Pavement Evaluation Unit of the Research and Materials Laboratory will measure the rideability of the pavement surface. The Resident Construction Engineer will contact the Pavement Evaluation Unit to schedule the testing at least 5 days in advance of need. The Contractor is responsible for providing a clean surface free of obstacles and the necessary traffic control for SCDOT to safely conduct the test. On large paving projects, testing should be performed on subsections, rather than waiting for the entire project to be completed. This will allow early detection of ride quality problems and will allow the Contractor to adjust the paving operation, if necessary. The Contract Specifications will define the method of measurement, the allowable roughness and the pay schedule for the project.

501.7 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The criteria for measuring and paying for PCC pavement construction will be defined in the Contract Specifications and is primarily based on the surface area of pavement placed and accepted, adjusted for thickness, smoothness and other deficiencies as needed. Document all measurements and field notes in the Daily Work Report and applicable SCDOT Construction Forms.

Section 502
Concrete Pavement Patching

502.1 DESCRIPTION OF WORK

Full-depth patching generally consists of removing and replacing deteriorated concrete pavement sections to the full depth of the concrete slab. The Resident Construction Engineer and SCDOT Inspectors will inspect the Contractor's work and materials. Section 501 presents guidance on PCC pavement construction that, in general, can be applied to other work with Portland cement concrete.

502.2 PRECONSTRUCTION CONSIDERATIONS

502.2.1 Materials Considerations

Verify that the type of Portland cement, aggregate and admixture materials required for the PCC patch mixture are supplied from SCDOT-approved sources, as discussed in Section 501.3. When the use of rapid patch material is specified, verify that it is supplied from a manufacturer listed on SCDOT Approval Sheet 22. Retain in the project files the manufacturer's Certificates of Compliance for materials received at the job site. Check that dowel bars and tie bars are of the type required by the Contract. SCDOT does not pre-approve reinforcing steel, therefore, obtain and submit the required samples for testing by the Research and Materials Laboratory. See Section 501.4 for additional information. Check the epoxy adhesive material for compliance and, as needed, have the Contractor verify the pullout strength through demonstration, as provided for in the Contract.

502.2.2 PCC Patch Mix Design

The Contractor will submit a proposed Mix Design to the Research and Materials Laboratory for approval. Ensure that the Mix Design for the PCC patch mixture has been approved by the Research and Materials Engineer.

502.2.3 Patch Area

The Resident Construction Engineer will mark the boundary for the area to be patched. The boundaries of the patch area must be in accordance with the Contract Plans and Specifications.

502.2.4 Air Temperature

Prior to patching, check the air temperature for compliance. The air temperature should be 40°F and rising, unless otherwise specified.

502.3 INSPECTION DURING CONSTRUCTION

502.3.1 Removal of Pavement

Without damaging the concrete to remain, a diamond tipped blade will be used to cut the existing pavement as marked by the Resident Construction Engineer and to the depth of the underlying base course. Overcuts into the adjacent slabs must be sealed with epoxy.

502.3.2 Inspection of Base Course

Once the defective concrete has been removed, inspect the soundness of the underlying base course. The base may need to be removed and replaced with suitable material and reworked. All materials must be thoroughly compacted using vibratory compactors to proper grade depth.

502.3.3 Inspection of Adjacent Concrete

Check the soundness of the vertical faces of the adjacent concrete pavement. The limits of patching may need to be extended. The vertical faces must be protected from damage.

502.3.4 Installation of Dowels / Tie Bars

After removing the deteriorated pavement, new dowels and tie bars will generally be placed in the vertical faces of the remaining concrete slabs. The details for installing dowels and tie bars in joints will be provided in the Contract Plans. Contact the Pavement Design Engineer for any needed clarification on the installation of these devices.

502.3.5 Preparation of Patch Area

Sandblasting and compressed air will be used to clean the contact surfaces of the slabs adjacent to the patch.

502.3.6 Concrete Placement / Consolidation

Prior to placing concrete, the base should be moist. Check that the concrete is properly placed in the patch reservoir without segregation. Hand-operated spud vibrators, set to the proper frequency, will be used to consolidate the concrete.

502.3.7 Surface Texture

Verify that the surface of the patched area has been textured to match the surface of the adjacent pavement.

502.3.8 Concrete Curing

Ensure the Resident Construction Engineer has approved the method of curing. Check that the curing compound has been applied at the proper rate to the surface of the patched area. Ensure that curing blankets have been placed to protect the pavement until sufficient strength is attained. The blankets should not be placed until the concrete has set sufficiently to prevent damage by the blankets.

502.3.9 Joint Sealing

Joints should be sealed in accordance with the Contract Plans and Specifications. See Section 504 for additional information.

502.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to opening to traffic, verify that the concrete used for the full-depth patch has attained the strength required by the Contract Specifications.

502.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure full-depth patching by the surface area of the accepted patch. Retain delivery tickets and SCDOT Form 700.04 – Ready Mix Concrete Report. See Section 501.7 for information on documentation and payment considerations.

Section 503
Grinding and Texturing Existing Concrete Pavement

503.1 DESCRIPTION OF WORK

Pavement grinding and texturing is typically specified to restore the riding quality and texture of the surface of an existing PCC pavement. With the exception of joint sealing, all other rehabilitative methods specified will be performed before the grinding operation. The Contract Plans will designate the limits of treatment.

503.2 PRECONSTRUCTION CONSIDERATIONS

Check the grinding and texturing machine for compliance with specified criteria. Ensure the equipment does not cause strain or damage to the pavement. Ensure the Contractor performs a demonstration section for inspection and approval by the Resident Construction Engineer. The spacing between grinding blades should be adjusted to provide the proper longitudinal corduroy effect, which will be affected by the hardness of the aggregate in the existing PCC pavement.

503.3 INSPECTION DURING CONSTRUCTION

While the grinding machine may operate in either direction, the support equipment should be oriented in the direction of traffic to reduce confusion to motorists. Grinding should progress from the low side of the cross slope to the high side to avoid ponding of water at the shoulder or longitudinal joint. Traffic cones will be removed behind the operation, and the pavement markings that are removed will be immediately replaced. Before marking, ensure that the surface is clean and dry. Water used to cool the cutting blades also controls dust. Verify that the water is removed from the surface (e.g., vacuumed) and the slurry disposed of properly.

503.4 POST-CONSTRUCTION CONSIDERATIONS

Acceptance of the work will be based on evaluation of surface smoothness, as defined in the Contract Specifications.

503.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure grinding and texturing existing concrete pavement by the area treated in place. Payment will be based on the Contract unit price. See Section 501.7 for additional information on documentation and payment. Document all measurements and field notes in the Daily Work Report.

Section 504
Cleaning and Resealing Joints in PCC Pavement

504.1 DESCRIPTION OF WORK

Cleaning and resealing joints is used to restore existing PCC pavements. The work involves cleaning, preparing and sealing joints in the surface of the existing PCC pavement. This retards moisture from infiltrating the underlying layers of the pavement structure and prevents debris from entering the joint, which can cause premature failure of the pavement structure.

504.2 PRECONSTRUCTION CONSIDERATIONS

Check that the joint sealant material is of the type specified in the Contract. See Section 501.3 for additional information on SCDOT-approved materials. Check the equipment for cleaning and sealing joints for compliance with specified criteria.

504.3 INSPECTION DURING CONSTRUCTION

See Section 501.6.15 for information on joint sealing.

504.4 POST-CONSTRUCTION CONSIDERATIONS

Do not permit any vehicles on the treated section for a minimum of 2 hours after sealing. Watch for damage caused by traffic of the treated joints and require repair work to be performed based on the provisions of the Contract.

504.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure and document cleaning and resealing joints by the length of joints that were treated and approved. Payment will be based on the Contract unit price. Document all measurements and field notes in the Daily Work Report.

Section 505
Routing and Sealing Cracks in PCC Pavements

505.1 DESCRIPTION OF WORK

Routing and sealing cracks is used to restore existing PCC pavements. The work involves routing, cleaning, and sealing cracks with sealant. This retards moisture from infiltrating the underlying layers of the pavement structure and prevents debris from entering the joint, which can cause premature failure of the pavement structure. Cracks will be identified and marked by the Resident Construction Engineer.

505.2 PRECONSTRUCTION CONSIDERATIONS

Check that the joint sealant material is of the type specified in the Contract. See Section 501.3 for additional information on SCDOT-approved materials. Check the equipment for cleaning and sealing joints and cracks for compliance with specified criteria. A concrete saw with a pivotal router blade should be used to provide a joint reservoir.

505.3 INSPECTION DURING CONSTRUCTION

Ensure that the old sealant is removed and the crack refaced and cleaned as prescribed. Verify that the cracks are widened to the width and depth shown on the Contract Plans or as directed by the Resident Construction Engineer. For cracks 0.375 inch or greater in width, a backer rod will be installed at a uniform depth to prevent the entrance of sealant below the specified depth. Ensure the backer rod is installed to the manufacturer's recommendation and not stretched during installation. A blocking medium is optional for cracks less than 0.375 inch in width, as long as the seal produced is satisfactory. Verify that the sealant is installed in accordance with the Contract Specifications.

505.4 POST-CONSTRUCTION CONSIDERATIONS

Do not permit any vehicles on the treated section for a minimum of 2 hours after sealing. Watch for damage caused by traffic of the treated cracks and require repair work to be performed based on the provisions of the Contract.

505.5 DOCUMENTATION FOR PAYMENT

Measure and document routing and sealing cracks by length (rounded to the nearest 0.1 foot) of cracks that were treated and approved. Payment will be based on the Contract unit price. Document all measurements and field notes in the Daily Work Report.