5-01 Cement Concrete Pavement Rehabilitation

SS 5-01.1 Description

Rehabilitation of Cement Concrete Pavement is used to repair damage to the roadway, extend the life of the pavement, prevent further damage to the pavement, and to provide a smoother ride to the traveling public. The various types of rehabilitation each have specific methods and requirements for performing the work. The Project Engineer and the inspection team must be familiar with the specifications, Contract requirements, and techniques to be employed to accomplish the Work. In addition, all personnel must be familiar with and adhere to the traffic control plans.

Prior to beginning work, the Project Engineer must ensure that the Project Inspectors and Testers are properly qualified in the test procedures, are familiar with the testing requirements, and that the testing equipment is calibrated and available.

When saw cutting or diamond grinding is required, pay special attention to environmental requirements for the removal and disposal of concrete slurry.

SS 5-01.3 Construction Requirements

SS 5-01.3(1)A Concrete Mix Designs

Concrete patching material is used for spall repair and dowel bar retrofitting and cement concrete is used for replacing cement concrete panels.

SS 5-01.3(1)A1 Concrete Patching Materials

Materials – Concrete patching materials will meet the requirements of *Standard Specifications* Section 9-20. The Project Inspector needs to inspect and document all prepackaged cementitious materials to ensure that they are properly labeled and that the Contractor mixes them to the correct proportions, as specified by the manufacturer.

SS 5-01.3(1)A2 Cement Concrete for Panel Replacement

Concrete – Cement Concrete mixes used in concrete panel replacement have to meet the requirements of Section 5-05.3(1) and 5-05.3(2).

The Project Inspector will:

- ensure the mix design has been accepted prior to use

and

- visually verify that the concrete delivery ticket has all required information and that the concrete is in compliance with the mix design.

Acceptance of the mix is verified on the grade by testing the air content and taking 28 day compressive strength cylinders for testing. Acceptance testing for air content and compressive strength is required to be performed once per shift. The rapid compressive strength gain of some proprietary concrete mixes makes taking air content tests difficult and the field test may be waived at the Project Engineer's discretion.

Concrete for panel replacement may come from a ready mix plant or mobile mixer. The Contractor is required to calibrate mobile mixers in the presence of the Project Engineer prior to use on the project.

SS 5-01.3(1)B Equipment

The Project Inspector will verify that all equipment used by the Contractor is in good working order and can produce a panel to the correct grade and in compliance with the Contract Specifications.

SS 5-01.3(4) Replace Portland Cement Concrete Pavement (PCCP) Panel

When a PCCP panel is damaged too severely, the only repair possible is replacement of all or a portion of the panel. This is accomplished by saw cutting and removing the PCCP panel and placing new PCCP, dowel bars and tie bars.

The Project Inspector must ensure that panels to be removed are laid out according to the Plans or as designated by the Project Engineer. All perimeter saw cuts must be full depth. To prevent damage to adjacent slabs that are to remain, a second full depth relief cut is required 6 to 18 inches inside the panel in both the transverse and longitudinal directions. If these full depth relief cuts are not made the energy imparted lifting out and/or breaking up the panel may be transmitted to the adjacent panels that are to remain and cause damage. Overcutting of panels in adjacent lanes that are to remain is not allowed for relief cuts and should be minimized for the perimeter sawcuts.

Once the panel has been removed, inspect the Subgrade material and the adjacent panels for any damage. Ensure that Subgrade is compacted to grade prior to placement of new concrete. Crushed surfacing base course or hot mix asphalt may be needed to provide a level and firm surface. This is already included in the standard bid price of the Work. If the material is not compactable, remove it, place geotextile and crushed surfacing base course as detailed in *Standard Specifications* Section 5-01.3(4)D at the Project Engineer's direction. Should the material need to be removed, this Work, as detailed in items 1 through 5 of the *Standard Specifications*, is to be paid by force account.

Ensure dowel bars and tie bars are placed in accordance with the plan and meet the requirements of *Standard Specifications* Sections 9-07.5 and 9-07.6. Collect Manufacturer's Certificate of Compliance documentation (and Certificates of Materials Origin on federally funded projects) for all dowel bars and tie bars prior to use on the project.

If new concrete pavement is to be placed against existing concrete pavement, epoxy-coated dowel bars shall be drilled and grouted into the existing concrete pavement. Tie bars are required whenever four or more concrete pavement panels in a row are placed next to existing pavement. Corrosion Resistant Dowel bars may be used in place of epoxy-coated dowel bars in panel replacements described in *Standard Specifications* Section 5-01. Verify that placement and tolerances of dowel bars and tie bars are in accordance with *Standard Specifications* Section 5-01.3(4).

Ensure that bond breaking material is properly installed so there are no folds or tenting that will result in voids under the concrete panel.

The position of dowel bars may be adjusted in order to avoid unsound concrete or an existing dowel bar. It may be necessary to cut back the face of the adjacent panel to reach sound concrete to install dowel bars.

Panels replaced should be the full width of the existing panel and at least 6 feet in length.

The lift-out method of removing panels is less likely to damage adjacent panels than a breakup and clean-out method. The Project Engineer should consider allowing alternative relief saw cuts patterns if the Contractor is using the lift-out method provided the alternative method does not damage adjacent panels. A relief saw cut is not necessary along edges of the panel that are not adjacent to cement concrete pavement such as when the concrete panel abuts an HMA shoulder.

A smooth uniform foundation is one of the most important factors affecting PCCP performance. Ensure that the panel foundation does not have excessive variation in elevation or soft spots.

SS 5-01.3(5) Partial Depth Spall Repair

This work consists of removing and replacing a small portion of a concrete panel.

The Project Inspector must ensure that removal of existing pavement does not cause damage to any pavement that is to remain. The saw cut must be a minimum depth of 2 inches around the area to be removed. The saw cut area should be rectangular or circular and a minimum of 3 inches outside the area of spalled concrete. The pavement shall be removed to a minimum depth of 2 inches or to sound concrete as determined by the Project Engineer.

Materials – The concrete patching material needs to meet the requirements of *Standard Specifications* Section 9-20. Inspect and document all prepackaged cementitious materials to ensure that they are properly labeled and that the Contractor mixes them to the correct proportions, as specified by the manufacturer.

Equipment – Verify that all equipment used by the Contractor is in good working order, and meets the requirements of the Contract. Verify that jackhammers weigh no more than 30 pounds and chipping hammers weigh no more than 15 pounds.

Spall Repair Checklist

1. Ensure that quick setting concrete is placed and finished within the time limit set by the manufacturer.
2. Small repair areas that are less than 6 inches on a side and shallow spalls that will be removed by grinding are done at the Project Engineer's discresion.
3. Spall repairs that abut working joints or cracks require a compressible insert to reestablish the joint or crack. If the crack is not reestablished the patch material may delaminate or spall.
4. Check the area around the spall for delamination. If delaminated areas are found they should be included in the spall repair.
5. Limit spall repairs to ½ the thickness of the panel. Deeper repairs require a partial or full panel replacement.

SS 5-01.3(6) Dowel Bar Retrofits

Dowel bar retrofitting is used to ensure transfer of loads between adjacent roadway panels and is combined with pavement grinding to extend the service life of the pavement. This increases the stability of the roadway by restricting differential movement of the panels and reducing vertical movement. Dowel bar retrofits are accomplished by cutting slots in the pavement, placing dowel bars, and filling with concrete patching material.

The Project Inspector will verify that the slots are:

- located in accordance with the plan
- cut parallel to the centerline of the roadway and to each other
- centered over the transverse joint

All exposed surfaces and cracks in the slot must be sand blasted to a clean concrete surface. All grout residue and debris must be removed from the slot, using either an air compressor or, if allowed, a high-pressure water blast.

Ensure that dowel bars meet Contract requirements and are placed in accordance with the Plans. Foam core inserts shall be placed at the middle of the dowel, in line with the transverse joint, must fit tightly to the sides and bottom of the slot, and extend to the top of the existing pavement. It is important that the foam core inserts line up with the transverse joints. The top of the foam core insert will be removed when the joint is saw cut through the section. Transverse joints open ¼ inch or more must be caulked to prevent patching material from entering the joint.

Concrete patching material shall be placed in the slots in a manner that does not disturb the dowel bar and to a level slightly above the level of the surrounding roadway.

Diamond grinding of the roadway surface is required within 10 working days of placement of the concrete patching material to provide a smooth surface.

Materials – The Contractor shall use concrete patching materials meeting the requirements of *Standard Specifications* Section 9-20. Inspect and document all prepackaged cementitious materials to ensure that they are properly labeled and that the Contractor mixes them to the correct proportions, and follows any placement restrictions, listed on the packages.

Ensure that dowel bars are placed in accordance with the Plans, and meet the requirements of *Standard Specifications* Section 9-07.5(1) or 9-07.5(2). Collect Manufacturer's Certificate of Compliance documentation (and Certificates of Materials Origin on federally funded projects) for all dowel bars prior to use on the project.

Equipment – Verify that all equipment used by the Contractor is in good working order, and meets the requirements of the Contract. Ensure that air compressors are of sufficient size and capacity to perform the work.

SS 5-01.3(9) Portland Cement Concrete Pavement Grinding

Diamond grinding of PCCP panels increases ride smoothness, reduces bumps following dowel bar retrofitting and increases the PCCP pavements life.

The Project Inspector will ensure that grinding begins within 10 working days of dowel bar placement and once begun, is a continuous operation until completed. Pavement shall be ground in a longitudinal direction removing a minimum of ⅛ inch from 95 percent of the surface to be ground.

If new cement concrete pavement is to be placed adjacent to rehabilitated cement concrete pavement, one pass must be ground along the edge of the rehabilitated pavement adjacent to where the new pavement will be placed. This will assure a smooth surface for the paving screed.

Equipment – Verify that all equipment used by the Contractor is in good working order, and meets the requirements of the Contract. Ensure the diamond grinder is of sufficient size and capacity to perform the work.

SS 5-01.3(10) Pavement Smoothness

Longitudinal surface smoothness of Cement Concrete Pavement grinding is accepted by the percentage of improvement when using the Mean Roughness Index (MRI).

The Contractor is responsible for providing the inertial profiler and operator used for smoothness testing. To ensure the profiler is accurate and the measured profile is repeatable, the inertial profiler must have been certified within the last 12 months and the operator must have been certified within the last three years. Inertial profilers will either be certified by a certification facility or by another state. Profilers certified by a certification facility are required to display a decal or other approved marking as evidence of certification and the certification expiration date. If the inertial profiler is certified by another state, the Contractor is required to submit documentation verifying the profiler certification. Contact the State Pavement Office to verify that the certification meets the requirements of AASHTO R 56.

The Contractor is required to collect a control profile of the existing pavement before any pavement rehabilitation work has started. Work such as panel replacement or spall repair will alter the MRI and make accurate determinations of the pre-existing MRI impossible. After completion of Work in the travel lanes the Contractor is required to collect an acceptance profile. Acceptance is based on the percentage improvement between the control profile and acceptance profile. There is no incentive or disincentive for MRI of cement concrete pavement grinding. The Contractor is required to perform corrective action if the MRI does not meet requirements. If the Project Engineer determines that corrective action does not or will not produce a satisfactory result the pavement may be accepted with a credit in accordance with Section 5-01.5.

The Contractor is not responsible for cracks in the existing roadway and dips that are too deep to remove by grinding and 0.01-mile sections with these deficiencies are excluded from the MRI analysis. Tenth mile sections should also be excluded if they contain more than three 0.01-mile sections with these types of deficiencies. However; individual 0.01-mile sections that did not have deficiencies must still meet the 160 inches/mile requirement for 0.01-mile sections even though they are in the excluded 0.10 section.

5-02 Bituminous Surface Treatment

GEN 5-02.1 General Instructions

Bituminous Surface Treatment (BST) construction proceeds very rapidly and it is very important that the Project Inspector be entirely familiar with the specifications and methods applicable to the Work. If the Work begins without proper preparation and planning, it is entirely possible that a major portion of the job will be completed before correction of any improper methods or procedures can be made. Project Inspectors should thoroughly review *Standard Specifications* Section 5-02, the Plans and the Contract Special Provisions well in advance of BST construction.

Carefully review *Standard Specifications* Section 5-02.3(10) concerning unfavorable weather and calendar cutoff dates well in advance of any bituminous paving work. In no case should bituminous surface treatments be placed before May 1 or after August 31 of any year except upon written order of the Project Engineer.

To correct the volume of the material to 60°F, the Project Inspector may use 240 gallon per ton at 60°F for all grades of emulsified asphalt.

When payment for asphaltic materials is by the ton, they should be measured by weighing. When it is impractical to weigh the materials, the quantity of asphaltic material used may be measured by the gallon and the number of gallons converted to tons with the appropriate temperature volume correction.

GEN 5-02.3 Inspection and Sampling of Materials

Emulsified Asphalt – Each shipment of emulsified asphalt arriving on the job by tank truck shall be inspected and must have a Certification of Shipment. The tank must be inspected after it is unloaded to see that no emulsified asphalt remains in the tank.

The Project Inspector must check and record the temperature of each load of emulsified asphalt as it is delivered to the roadway for spreading.

Samples of the emulsified asphalt shall be taken as required in Section 9-4.2, and shall be submitted to the State Materials Laboratory for Testing.

Aggregates – No aggregate shall be used without the acceptance of the State Materials Laboratory. If any question arises concerning quality of the material, a sample shall be sent to the State Materials Laboratory for testing before use and preferably during plan preparation.

GEN 5-02.4 Miscellaneous Inspection Duties

Control of Traffic – Make frequent checks of traffic control operations to see that traffic is being conducted through the job in a safe, orderly manner. When spreading emulsified asphalt, traffic should not be allowed to travel past the distributor. Control of the speed of traffic is very important, especially during the early curing stage of the asphalt, to ensure the aggregate covering the asphalt is disturbed as little as possible. Control of traffic must be maintained as long as required to prevent excessive loss of the aggregate. The Project Inspector must ensure that all warning signs are properly in place throughout construction.

Maintenance and Finishing Roadway – The Project Inspector shall see that the newly completed roadway is properly maintained until brooming is completed. The Contractor shall be required to keep sufficient equipment on the job to adequately handle any situation that may develop, including application of a fog seal or additional emulsified asphalt or aggregates if deemed necessary by the Project Engineer per SS 5-02.3(6). Before the Work is accepted, the Contractor is required to finish the roadway and clean up any debris resulting from their operations, as required in the *Standard Specifications*.

Measurement of Stockpiles – Before construction begins, measure and compute quantities from stockpiles that will be utilized for materials. Upon completion of the Work, the Contractor shall be required to leave the remaining materials in neat, presentable stockpiles. The stockpiles shall again be measured and quantities determined. The difference in quantities obtained by this procedure will aid in checking pay quantities determined by truck volumes. It will also serve as an accurate basis for reporting quantities withdrawn from stockpiles. Measurement of stockpiles will not be necessary on projects where the aggregate is furnished by the contractor.

Notice to Maintenance Superintendent – The Project Engineer should keep the area Maintenance Superintendent informed of the Contractor's proposed progress schedule so that maintenance operations can be coordinated to accommodate the construction work. The Project Engineer must also notify the Maintenance Superintendent of the date when the Contractor's maintenance period will expire so that maintenance of the roadway may be taken over by WSDOT and maintained without interruption. These notices should be given sufficiently in advance to enable the Maintenance Superintendent to provide equipment and organize the work.

GEN 5-02.5 Reports and Records

A Daily Report of BST Operations (DOT Form 422-644) shall be completed by the Project Inspector at the end of each day's work, showing type of work, areas treated, quantities used, etc. This report shall be submitted in duplicate for the Project Engineer and Region.

Records of quantities of emulsified asphalt and aggregate used shall be kept in the Inspector's Daily Report, and shall be checked daily against quantities shown on tickets issued to the Contractor. Accurate, neat records are invaluable to the Project Engineer in preparing estimates and final records. See Section 10-2 for instructions concerning quality control procedures.

The Project Inspector shall include all pertinent information concerning each day's Work in the Inspector's Daily Report.

SS 5-02.3 Construction Requirements

SS 5-02.3(1) Equipment

Inspection Tools and Equipment – Before construction begins, the Project Inspector shall ensure all equipment necessary to carry out the inspection duties is available and on-site. This equipment shall include air and asphalt thermometers, a device to measure surface temperature, wind gage, sieves and scale, tapes and rules, canvas sample sacks, containers for sampling asphalt, notebooks, ticket books and diary book.

Inspection of Contractor's Equipment – Prior to construction of the bituminous surface, inspect the Contractor's equipment. Check to see that all required equipment is available, in good condition, and is properly adjusted.

Carefully check the asphalt distributor to ensure that it meets the requirements of the Specifications. Verify the capacity of the distributor, and ensure that the volume gauge is calibrated to correctly indicate quantities in the tank.

Special attention should be given to the condition and adjustments of the asphalt pump, spray bar and spray nozzles. The nozzles should be set uniformly at the proper angle from the axis of the spray bar, normally 15 to 30 degrees, to eliminate interference of the sprayed material from one nozzle with that from an adjoining nozzle. Each nozzle should be set at the same angle. The height of the spray bar must be checked to see that the correct overlap of the spray from each nozzle is obtained. This can be accomplished by plugging alternate nozzles and adjusting the height of the spray bar until the edges of the spray fans from the unplugged nozzles just meet at the roadway surface. When all nozzles are spraying, an exact coverage of emulsified asphalt will be obtained, resulting in an application of emulsified asphalt free from longitudinal streaking.

The asphalt pump must be checked to ensure that the manufacturer's required pressure can be maintained uniformly.

The Project Inspector must check the motor patrol graders, rollers, spreader boxes, etc., to ensure that they are in good operating condition, and that the motor patrols are equipped with the required moldboard brooms. Determine the capacity of hauling trucks and water tanks from measurements obtained on the job, and record the results for future reference.

SS 5-02.3(2) Preparation Of Roadway Surface

SS 5-02.3(2)A New Construction

The roadway surface shall be shaped and compacted to a smooth, uniform grade and cross-section before application of the emulsified asphalt. If possible when setting grade, do not place stakes, hubs, etc. in the roadway, as this may cause faults in the finished surface. If stakes or hubs must be placed in the roadway in order to set the grade, these stakes or hubs must be removed and the void filled and compacted prior to placement of the surface treatment. No traffic will be allowed on the prepared surface until the first application of asphalt emulsion and aggregate is applied. It is essential that the grading of the surfacing material be uniform over the area to be treated to allow uniform penetration of the emulsified asphalt. This is different work than that associated with shaping and compacting of crushed surfacing as required in *Standard Specifications* Section 4-04.3(5). The quality and smoothness of the finished roadway depends to a great extent on the quality of the work done in preparing the roadway. Careful inspection during this operation will lay the groundwork for a smooth riding and uniform appearing finished project.

In many instances, the surfacing course upon which the bituminous surface treatment is to be placed will be segregated, rutted and pot-holed by traffic using the roadway prior to oiling. Such a surface must be completely processed to the depth of the ruts or potholes, and re-laid. Do not allow the Contractor to merely lightly blade the surfacing course, filling the holes with loose, segregated material. Such procedures are sure to result in a rough uneven pavement, due to differential compaction and penetration.

Do not allow the Contractor to merely lightly blade the surfacing course, filling the holes with loose, segregated material. Such procedures are sure to result in a rough and uneven pavement, due to differential compaction and penetration.

The surfacing must be damp, bladed, and thoroughly rolled to obtain a dense, unyielding base for the bituminous surface treatment. If additional water is required, it shall be applied in the amount and at the locations designated by the Project Inspector. The final coverage must be with a steel-wheeled roller to produce a smooth surface upon which to apply the first application of emulsified asphalt. The blading and rolling of the surfacing shall be coordinated so the emulsified asphalt will be applied while the surfacing material is still damp. If the surfacing material compacts to a very tight surface, the emulsified asphalt will not penetrate as much as if the material is more open. If this is the case, the Project Inspector should ensure that the top coat of emulsified asphalt is not applied too heavy.

SS 5-02.3(2)B Seal Coats

- **New Construction** – The surfacing needs to be dampened, trimmed, and rolled to provide a uniform grade and cross section according to the plans. Surface soft spots need to be excavated and repaired with the same type of surfacing material. The amount of water applied needs to be the optimum amount necessary to tighten the surfacing enough to minimize its porosity and absorption of the first application of emulsified asphalt. Traffic should not be allowed on the prepared finished surfacing.
- **Existing Roadway** – Prior to the first application of emulsified asphalt, the Project Inspector shall ensure that the existing surface is broomed clean and that holes and breaks are patched as required. Inspect the existing surface carefully over the length of the job, noting the surface characteristics of the roadway, so that the rate of application of emulsified asphalt best suited to the conditions can be determined. Document varying conditions and plan to vary the application of emulsified asphalt accordingly.

  Areas of the roadway showing failure caused by soft Subgrade or poor drainage must be removed to correct the cause of the failure.

  Open or porous paved surfaces, particularly on recently constructed bituminous pavements found in the area to be treated, the Project Inspector shall require the application of a fog seal to be applied before construction of the seal coat. If fog seal is not shown on the Plans, inform the Project Engineer so that a supplemental agreement may be reached with the Contractor.

  The Project Inspector is responsible to see that a newly constructed bituminous surface be allowed the required time for curing before allowing construction of the seal coat over the affected area.

SS 5-02.3(3) Application of Emulsified Asphalt and Aggregate

The Project Inspector shall require that the Contractor provide a minimum 1,000-foot test strip to verify that the Contractor's equipment is functioning according to specification.

Building paper shall be placed at the joint, each time the distributor starts, in a manner that assures a uniform asphalt emulsion spread across the area of the joint.

During the application of the emulsified asphalt, maintain a close inspection of the roadway to see that the emulsified asphalt is applied in a uniform manner. Longitudinal joints will be allowed only at the centerline of the roadway, the center of the driving lanes, or the edge of the driving lanes. If evidence of improper application is apparent, the operation must be stopped to make required corrections. Check to see that the asphalt pump pressure and the speed of the distributor are maintained at uniform rates to ensure

even application of the emulsified asphalt. A record shall be made of each distributor load applied, showing area treated, gallons spread, temperature of emulsified asphalt, etc. The Project Inspector should compute the yield of each spread in gallons per square yard depending on diluted or undiluted emulsified asphalt.

Part of the first application of emulsified asphalt applied to the surfacing penetrates the material and the rest remains on the surface and surrounds the aggregate. Constant checking is necessary to ensure that enough emulsified asphalt is applied to fill the voids and adhere to the aggregate. Conditions may change during the day due to weather or the preparation crew's efforts to stay ahead of the oiling crew. Some bleed can be tolerated on the first application as it can be corrected on the second application if uniform in nature. The final mat will be thicker and better if the optimum amount of emulsified asphalt is used, without excessive bleed, on the first application.

Stockpiled aggregate shall be inspected to ensure that the grading of the material meets specification, and to verify that it is damp at the time of loading onto trucks for hauling to the roadway. If dry or dusty, the material in the stockpile must be watered to produce a damp surface condition. The emulsified asphalt does not readily coat a dry dusty surface. During warm weather, the moisture on the surface of the aggregate will quickly evaporate after the aggregate is spread and the emulsified asphalt is applied to the roadway.

The Project Inspector must frequently check the truckloads of aggregate at the point of delivery, to verify that the trucks are completely loaded and that the material is damp. Tickets shall be issued for each load of material received or a receiving report record made as the loads of material are received. A record shall be made of the quantities of material used on each section.

Following the application of emulsified asphalt, the Project Inspector is responsible for ensuring that the aggregate is applied in accordance with the specifications. The aggregate needs to be applied at the correct rate within the allotted time limit. The roadway shall be inspected for signs of skips or omissions in the application of the aggregate. Any omissions shall be immediately covered by re-spreading with the chip spreader or by hand-spotting methods. Do not allow excessive amounts of aggregate to be applied, as this will result in waste of the material and require harmful excessive brooming.

Careful inspection and control of the rolling operation must be made to ensure that the requirements of the specifications are met. It is important that rolling be conducted as soon as possible following application of the aggregate in order to properly imbed the aggregate in the asphalt. Adequate rollers must be present to provide complete coverage without excessive speeding and abrupt starting/stopping motions.

Chips are broomed once the emulsified asphalt cures enough to adhere the chips to the roadway. Brooming is necessary to prevent wheel tracking promoted by loose aggregate on the roadway. Areas of severe bleeding will need to be blotted with ¼-inch material during the cure period. Emulsified asphalts do not really cure except for water evaporation when they break. The constructed area will be tender, although probably ready for the next construction step.

When the asphalt has set, adhesion has developed and the chances of bleeding are remote.

The excess aggregate on the edge of the roadway shall be broomed off as it is a hazard to traffic and reduces the usable width of the roadway.

SS 5-02.3(5) Application of Aggregates

Construction of Seal Coat

When constructing a seal coat, the emulsified asphalt thickness is critical to ensure the layer of aggregate placed on the emulsified asphalt is covered appropriately. Constant checking is required to ensure that embedment of the major stone in the asphalt is 50 to 70 percent. When ½-inch to No. 4 chips are used on routes with moderate traffic volumes, choke stone may be used either ahead of or immediately behind the main rollers. Some bleed is inevitable at intersections, on steep hills, and at severe horizontal or vertical curves. This is preferable to losing rock on long sections in between, due to insufficient emulsified asphalt being placed.

Continuously inspect the aggregate application on the freshly spread emulsified asphalt, to ensure that the material is placed within the time allotted, to ensure the spread of emulsified asphalt is not extended beyond the area which the Contractor can cover.

Omissions or skips in the spreading of aggregates must be immediately covered by re-spreading with the chip spreader or by the hand spotting crew.

The best seal coats are obtained on those jobs where the time elapsed between spreading of asphalt and application of aggregates is held to the time allotted.

The Project Inspector must ensure that the rolling operation is not allowed to lag far behind the spreading of aggregates. It is important that the aggregate be rolled into the asphalt film as soon as possible following application.

Spreading Choke Stone – When constructing Bituminous Surface Treatment Seal Coats, the specifications may require application of choke stone following the spreading and rolling of the coarse aggregates. The Project Inspector must exercise judgment in determining the time for applying the choke stone. When using emulsified asphalt, the choke stone should be applied immediately, sometimes even before initial rolling.

Choke stone, applied at the proper time, will key the gaps between the particles of coarse aggregate and provide a smoother riding surface, as well as absorb any free asphalt which might bleed to the surface of the coarse particles.

By observing conditions and results carefully, the experienced inspector will determine the procedure which produces the best results under any particular condition.

If the sealed roadway is rained on before the asphalt has cured and the asphalt starts to emulsify under the traffic, the roadway can usually be saved from damage by applying choke stone on the roadway to prevent the traffic from picking up the asphalt. Refer to the Spill Prevention Control and Countermeasures Plan (SPCC plan) for guidance on using Best Management Practices (BMPs) to protect the environment.

SS 5-02.3(9) Protection of Structures

When spreading emulsified asphalt or aggregate near curbs, bridge rails, drainage inlets, monument covers or other structures, adequate protection must be provided to prevent damage to the structures. The Project Inspector shall see that any emulsified asphalt sprayed, or aggregate spread, on or in a structure is satisfactorily removed by the Contractor.

5-03 Crack and Joint Sealing

GEN 5-03.1 General Instructions

Crack sealing is one of the most cost-effective methods of pavement preservation. Joint sealing is required anywhere there is a joint including between different surface types, at bridge ends, and between PCCP panels. Joint sealing helps restrict the infiltration of water into the Subgrade and prevents incompressible material from entering the joint causing spalling when the joint closes up during warmer conditions.

The Project Inspector should ensure the proper material has been selected for the application. For bituminous pavements the material msut follow the selection table in SS 5-03.3(2)A. Material selection depends on whether the sealant is used in a crack or a joint. Furthermore, if sealing cracks, there are different materials depending on the size of the crack and if there will be any additional surfacing materials placed over the crack after sealing. Placing Hot Mix Asphalt over the top of a crack sealed with Hot Poured Sealant can cause bumps. Different types of crack and joint sealant material are required for use with Cement Concrete Pavements; see SS 9-04.2.

A properly constructed crack or joint seal will adhere to the sides of the crack or joint and flex with the thermal expansion and contraction of the pavement. To ensure proper adhesion the crack or joint will be properly prepared in accordance with SS 5-03.3(1)B and the Work should be done under the proper weather conditions, see SS 5-03.3(1)A. Review the Standard Specifications and manufacturer's installation instructions to identify any additional weather or preparation requirements specific to the material being used and the type of pavement being sealed, and the handling, heating, and storage requirements.

When filling cracks or joints the Project Inspector should be aware that in some situations the sealant may settle requiring the Contractor to return to top off the sealant material. The sealant material should also be confined to the crack or joint minimizing any sealant on the pavement surface. Hot Applied Joint Sealants often remain tacky after placement. When the cool tires roll over the hot HMA mix, the mix tends to stick to the tires, and is "picked" up from the mat on to the tires. Project Inspectors should watch for picking when the pavement is opened to traffic.

5-04 Hot Mix Asphalt

GEN 5-04.1 General Instructions

The technology of asphalt materials and mixes is continuously changing, and this in turn drives changes to the Contract Specifications. It is imperative to study Contract documents and Specifications prior to the start of any paving Contract. There also are many excellent handbooks that can be obtained to assist paving Inspectors and testers. It is recommended that the Project Engineer obtain copies of these handbooks as a resource for their office. Recommended books include "Hot Mix Asphalt Materials, Mixture Design and Construction" by the National Center for Asphalt Technology and "Construction of Hot Mix Asphalt Pavements (MS-22)" by the Asphalt Institute.

Good work and a successfully completed job depend on good equipment, skillful operation of the equipment, competent, knowledgeable supervision and inspection, and open lines of communications. Maintaining open lines of communication through informal daily meetings between the Inspector and Contractor can greatly improve the success of any job.

Hot mix asphalt (HMA) projects are not always built as originally scheduled. Changes may occur because of problems with material supply, equipment breakdown, Contractor and Subcontractor schedules, and weather conditions. Informal meetings on a regular basis provide a forum for the exchange of information and discussion of problems. To begin the communication process a prepaving meeting is recommended. The Project Engineer, paving Inspectors and testers together with the paving superintendents and paving foremen should be present to go over all activities and plan the entire operation. It is also advisable to include the Traffic Control Supervisor (TCS). The following checklist may be used as an outline for the prepaving meeting:

Prepaving Checklist

1. Review the HMA Contract requirements with the Contractor to include:
   a. HMA class
   b. Grade of asphalt binder
   c. Evaluation and acceptance procedures
   d. Mix design being approved on the QPL
   e. Mix design submittal for approval to use on the Contract
   f. Mixture test section (HMA mixture if required or requested)

   If an HMA additive that reduces the optimum mixing temperature or serves as a compaction aid for producing HMA is proposed the Contractor is required to submit the request on Form 350-076 (*Standard Specifications* Section 5-04.2(2)B)
2. Review procedures in *Standard Specifications* Section 5-04.2(2)A for modifying the job mix formula (JMF)
3. Discuss construction of HMA mixture test section (*Standard Specifications* Section 5-04.3(9)A)
4. Discuss the communication procedure to be used for weather shut downs and other potential construction problems

5. Review what type of material transfer equipment (vehicle or device) the Contractor plans on using
6. Discuss testing for low cyclic density (*Standard Specifications* Section 5-04.3(10)B) and what to do if segregation of the mix is occurring
7. Discuss the preparation of the existing paved surfaces (*Standard Specifications* Section 5-04.3(4)) including cleaning the pavement, application of tack, pickup problems, weather limitations (*Standard Specifications* Section 5-04.3(1), crack sealing (*Standard Specifications* Section 5-03), and pavement repair (*Standard Specifications* Section 5-04.3(4)C)
8. Discuss aggregate sampling and testing requirements (*Standard Specifications* Section 5-04.3(8) and 3-04
9. Mixture sampling and testing:
    a. Who and how (*Standard Specifications* Section 5-04.3(9)),
    b. When (*Standard Specifications* Section 5-04.3(9)B1)
    c. Notification of mixture acceptance test results (*Standard Specifications* Section 5-04.3(9)E)
    d. Mixture acceptance pay factors (*Standard Specifications* Section 5-04.3(9)B4)
    e. Mixture acceptance Composite Pay Factors (CPF) (*Standard Specifications* Section 5-04.3(9)B5)
    f. Mixture acceptance price adjustments (*Standard Specifications* Section 5-04.3(9)B6)
    g. Contractor requests for mixture sublots to be retested (*Standard Specifications* Section 5-04.3(9)B7)
10. Review the requirements for the Contractor to maintain a CPF greater than 1.00 for aggregates in 3-04.3(7)D3, and for mixture and compaction in 5-04.3(11)F. The intent of these particular Specifications is to maximize the likelihood that WSDOT will receive all materials and all compaction at CPF's and pay factors of 1.00 or greater. This requires the Paving Inspector and Contractor to evaluate the updated CPF and pay factors every time a test on aggregate, mixture, or compaction is completed. When the CPF and pay factors fall below threshold values of 1.00, 0.95, or 0.75, the Contractor must immediately take the actions described in the Specification. The need for the Contractor and Paving Inspector to be made immediately aware of the changing CPF and pay factors after each test reinforces the need for the test results to be processed into the Materials Testing System (MATS) and the Statistical Analysis of Materials program (SAM) within 24 hours.
11. Review sampling of the asphalt binder, the maximum recommended temperature for heating the asphalt binder and the maximum allowable temperature for discharge of the HMA (*Standard Specifications* Section 5-04.3(3)A item 3 and 5-04.3(6) respectively) for the type(s) of asphalt binder being used on the Contract. The Contractor will supply the information from the manufacturer of the asphalt binder.
12. Review the procedure and timing in obtaining density gauge correlation factors

13. Review Contract requirements for asphalt densities:
    a. When (*Standard Specifications* Section 5-04.3(10)C1)
    b. Who and how (*Standard Specifications* Section 5-04.3(10)C2
    c. Notification of compaction test results (*Standard Specifications* Section 5-04.3(1)F)
    d. Contractor requests for cores and utilization of core results (*Standard Specifications* Section 5-04.3(10)C4)
14. Review construction of transverse joints (*Standard Specifications* Section 5-04.3(12)A), and longitudinal joints including the notched wedge joint and when/where it will be required (*Standard Specifications* Section 5-04.3(12)B)
15. Traffic control procedures and lines of communication including allowable times for lane closures
16. Other factors specific to Contract or of concern by those attending

In the construction of HMA, it is extremely important that the material meets all requirements of the Specifications. It should be remembered that Specifications are not arbitrarily arrived at, but have evolved through the years as a result of experience and research.

Experience has shown that pavements that do not meet all Specifications will not perform satisfactorily, resulting in high maintenance costs and reduced service life. The responsibility for obtaining a mixture in close conformance with the Contract mix design and meeting the Specification requirements rests with the Contractor. The importance of this cannot be overemphasized, since the best possible construction at the lowest cost to WSDOT cannot be obtained unless the mixture produced at the plant is uniform and of good quality. One of the key words used to describe quality production of HMA is UNIFORMITY.

- The aggregate in the stockpile must be of UNIFORM quality and gradation.
- Aggregate must be fed into the plant in a UNIFORM, controlled manner.
- The heating and drying of the aggregate must be UNIFORM.
- The separation of the aggregate in the bins must be UNIFORMLY controlled.
- The aggregates and asphalt must be combined and mixed in a UNIFORM, consistent manner.

In order to achieve this uniformity, it is necessary that the entire operation be conducted so that each phase of the production operation is in balance with all other phases. To accomplish this most Contractors have a Quality Control (QC) program.

With the advent of Quality Assurance (QA) Specifications and statistical evaluation of HMA, the role of inspection has evolved from one that was highly involved in the operation of the asphalt plant to one that is involved in verification that the material the Contractor produces is in conformance with the JMF and in accordance with the Specifications.

An Inspector's Daily Report must be kept, showing all instructions received from the Project Engineer and instructions issued to the Contractor.

Careful review of *Standard Specifications* Section 5-04.3(1) concerning weather limitations and calendar cutoff dates should be made in advance of any HMA paving so the Work can be planned and completed prior to any unfavorable weather. Pavement performance

is highly dependent on the weather conditions in the first weeks and months following paving. Invariably, when these Specifications are not closely adhered to, early pavement performance problems occur. Therefore, beginning October 1 of any year through March 31 of the following year, no wearing course is to be placed without written authorization of the Project Engineer. The Project Engineer will review this decision with the Region Construction Office prior to allowing any paving outside these dates.

In addition, use of a pneumatic tired roller is required from October 1 through March 31 (*Standard Specifications* Section 5-04.3(10)A). It has been shown that during warmer weather, traffic will knead the HMA providing a more durable pavement. To duplicate this benefit for late season paving, use of pneumatic tired rollers is part of the Specifications.

Placement of HMA less than 0.10 feet or less is not recommended for surface temperatures less than 55˚F for wearing course and 45˚F for other courses (*Standard Specifications* Section 5-04.3(1)). Heat loss in thin lifts is very quick and in most cases inadequate time is available for placement or to achieve needed compaction.

A word about the writing style used in Section 5-04:

> For those parts of *Standard Specifications* 5-04 which tell the Contractor what to do, the writing style, beginning with the February 2016 Amendments, is different from the rest of the *Standard Specifications*. Referred to as “active voice, imperative mood”, this style is more “directive” in its tone, and has been adopted as the writing style of preference for all Contract Specifications by AASHTO and FHWA. It is used in Section 5-04 on a trial basis to see how well it is received and understood by users, including industry and Inspectors. If well enough received, it may be adopted as WSDOT’s standard style for writing Contracts.

SS 5-04.2 Materials

Mix design approval involves two steps - (1) approval on the QPL, and (2) approval for use on a particular Contract.

SS 5-04.2(1) How to Get an HMA Mix Design on the QPL

The process for getting a mix design approved for listing on the QPL does not involve the Project Engineer’s office. This is because the process occurs outside of any construction Contract. The HMA producer works directly with the State Materials Laboratory in all aspects of this process. Refer to SS 5-04.2(2).

If the HMA producer’s proposed mix design is approved for listing on the QPL, the State Materials Laboratory will assign a mix ID number (a unique identification number) that has “MD” as its prefix. The “MD” prefix indicates the associated mix design is the original mix design approved by the State Materials Laboratory, and therefore does not include any changes to the JMF which are allowed under SS 5-04.2(2)A.

SS 5-04.2(2) Mix Design - Obtaining Project Approval

The Contractor is required to use a QPL approved mix design for the HMA that meets the requirements of the Contract. After identifying the mix design it intends to use from the QPL, the Contractor submits WSDOT Form 350-041 to the Project Office. The Project Office then requests approval for using the proposed mix design on its Contract by completing an HMA mix design submittal using the MATS program.

Note: It is extremely helpful to the State Materials Laboratory, when evaluating the mix design approval request, for the Project Office to make sure to convey the correct Specification year of the HMA required by the Contract. This is when the acceptance settings are first established in SAM for both mixture and compaction for that mix design on your Contract. If the Contract requires something other than an exact match of a Specification year for any of the items in the table in *Construction Manual* Section GEN 5-04.3(9)B3, contact the Assistant State Construction Engineer (ASCE) or the State Materials Laboratory, Bituminous Testing Engineer, at the same time the mix design approval request is submitted.

The State Materials Laboratory will evaluate the mix design approval request and respond to the Project Office. If approved, the mix design prefix will change from MD to RD, indicating "reference design".

Each approved HMA mix design will be listed on the QPL for 24 consecutive months.

The Contractor may propose a mix design that does not meet the Contract requirements, which would require an approved Change Order. (See the table below for information regarding HMA mix design Change Orders)

Change Order Approval Process for HMA Mix Design Substitutions

1. Purpose: Consistent approvals throughout the state (HQ, Region and PEO),
2. Use correct materials to ensure performance,
3. Consistent with the cost associated with change orders,
4. Avoid unintentional precedents and potential unfair bidding advantage,
5. Involve the right people in the approval process.

HMA Mix Design Change Order Approval Process

Change orders allow substitution, but do not guaranty HMA mix design approval.

Questions that need to be answered before processing a change order:

1. Does the plan HMA tonnage exceed 1,000 tons? If yes, stop and do not proceed with HMA mix design substitution.
2. What Class, ESAL level (gyration) and grade of binder does the Contract require?
3. What Class, ESAL level (gyration) and grade of binder is being proposed?
4. Are there any Special Provisions that need to be considered?
5. Where is the HMA to be placed? Is it structure, leveling, repair, etc.?
6. What is the risk of using a mix design that does not meet the Contract requirements? (Pavements & Materials)
7. How much time has the Contractor had between Award and Proposal of Change Order?
8. What is the anticipated date of paving?

Unacceptable Change Order Criteria:

1. A Contract that specifies a 100 gyration (> 3 mil. ESAL) asphalt mix design and a proposed change to use of a 75 gyration (< 3 mil. ESAL) mix design.
2. A Contract that specifies a PG "V" grade binder and a proposed change to use of a PG "H" grade asphalt binder.
3. Modifications to an approved QPL mix design such as increase or decrease to the binder content, require a test section, etc.
4. HMA Contract plan quantities exceed 1,000 tons.

Potentially Acceptable Change Order Criteria:

1. A Contract that specifies a 75 gyration (< 3 mil. ESAL) asphalt mix design and a proposed change to use of a 100 gyration (> 3 mil. ESAL) mix design.
2. A Contract that specifies a PG "H" grade binder and a proposed change to use of a PG "V" grade asphalt binder.
3. HMA Contract plan quantity of 1,000 tons or less.

Who to contact in determining if a Change Order is acceptable?

1. Project Engineer, Region Materials Engineer and HQ Construction Office; need to discuss what the Contract requires and the proposed change to the Contract?
2. Consult Pavement Design for pavement structure assessment to determine if proposed mix design is acceptable?
3. Consult Construction Materials for mixture specific details on proposed HMA mix design questions and to assist with determining if the proposed material change will meet performance and service life criteria.
4. If the answers to any questions 1 – 3 are No, or concerns are identified:

   The Contractor needs to use an approved mix design that meets the original Contract requirements.
5. If the answer to all the three questions above are yes:

   Then a Change Order could be processed to allow the alternative mix design from the QPL.

SS 5-04.2(2)A Mix Design - Making Adjustments to the JMF

During HMA production it may be necessary to make adjustments to the JMF to improve workability, compactibility, and volumetric properties (V_a and VMA). *Standard Specifications* Section 9-03.8(7) Sub-Section 2, defines the maximum adjustment allowed for aggregate and the asphalt binder content that can be approved by the Project Engineer. These adjustments can be made at the request of the Contractor and approved by the Project Engineer, provided the change will produce material of equal or better quality. The Project Engineer should consult the State Materials Laboratory or ASCE to confirm that the Contractor's proposed JMF change will indeed provide equal or better quality, before approving the proposed change.

Adjustments to aggregate gradation and asphalt binder content beyond the limits defined in *Standard Specifications* Section 9-03.8(7) may be allowed only with approval by the State Materials Engineer.

During construction, guidance for adjustments is provided through the use and interpretation of the compaction control and mixture test results.

The Contractor's plant operator must be advised of all results of sampling and testing performed.

GEN 5-04.2 Inspector Roles and Responsibilities

Testing Equipment – Before the production of HMA commences, the Inspector needs to ensure that all of the equipment needed to accomplish all of the test procedures has been obtained. In addition, qualified testers using calibrated or verified equipment are required. The Inspector needs to make sure that this equipment is in good working order and has a current calibrated or verified sticker on it, and that all tester qualifications are current.

The Inspector is charged with responsibility for care and safekeeping of all testing equipment that is issued. The equipment must be maintained in a clean and proper operating condition to ensure accuracy of test results. Special care must be exercised in the use and maintenance of sieves to see that they do not become clogged or damaged. Thermometers must be handled carefully to avoid breakage.

Electronic scales are expensive and delicate equipment. Particular care should be taken to protect them from theft or voltage spikes.

The ignition furnace is a high temperature oven, so care must be exercised in its operation and testers must be qualified in its use.

Given reasonable care, HMA testing equipment will give long and satisfactory service.

Required Tests – The Inspector is responsible to the Project Engineer for the required field tests as well as for submission of required samples to the State Materials Laboratory for testing. Testers must be qualified in the "Asphalt Module" or for the particular method of sampling and testing they will be performing. The QA Specifications intend for the Contractor to be totally responsible for the maintenance and operation of equipment and the production of the HMA. It is the Inspector's role to direct the Contractor when to take samples and observe the Contractor taking the samples while the Inspector performs the tests. However, it is not possible or desirable for the Inspector to take a "hands off" approach to the production of HMA. If the Inspector notices anything at all that affects the quality of the HMA, this information should be brought to the Contractor's attention in a cooperative manner so the situation can be corrected.

Notifying the Contractor of Test Results - Sections 5-04.3(9)E and 4-04.3(10)F of the *Standard Specifications* address how and when we are expected to provide the Contractor with official acceptance test results for mixture and compaction. We must do our best to get the results into SAM within 24 hours of receiving the sample from the Contractor, then the SAM program will email the test result to the Contractor if the Contractor has requested the email service. The intent of these Specifications is to be both correct and timely. The State Construction Office has no objection to providing unofficial test results to the paving Contractor as soon as the field test is complete, when so requested.

When providing preliminary test results to the Contractor before they have gone through the checks and approvals of MATS and SAM, remind the paving Contractor that the results are preliminary and therefore unofficial and, when appropriate, acceptance is by statistical evaluation.

The email to the Contractor mentioned above requires the Contractor to send a written request to the Project Engineer identifying the name of its designee and email address. Then, the Project Engineer's staff input the email address of the Contractor's designee

into SAM. For questions on how to make this happen in SAM contact the IT Help Desk at the State Materials Laboratory. Furthermore, because the information input into SAM is the official basis of notification and acceptance, it is critical that the data be input correctly, checked and done in a timely manner.

GEN 5-04.3 Street Inspection

General – In the construction of HMA pavements, it is the responsibility of the Street Inspector to see that construction methods and equipment used, as well as the finished pavement, meet the requirements of the Specifications. In order for the Street Inspector to properly discharge this responsibility, it is necessary that the Street Inspector thoroughly understand the *Standard Specifications*, the Special Provisions of the Contract, and the instructions set forth herein. The Street Inspector must also have a good working knowledge of methods and equipment involved in the construction of HMA pavements.

A means of communication between the Street Inspector and the Plant Inspector must be established, and the Street Inspector must keep the Plant Inspector informed of any difficulties encountered in the placement or compaction of the mixture or of any faulty mixture received at the paving site.

Street Inspector's Checklist – Some of the most important details of inspection on HMA paving are listed below:

1. Check condition and adjustment of paving machines and rollers before and during operation to verify no tearing or pickup of the mat.
2. Has width of spread in successive layers been determined to ensure joints are covered?
3. See that traffic control is organized and functioning properly; make sure required signs are in place and document it.
4. Check application of tack coat and do not allow tacking of more base than will be paved each day. Be sure the pavement is swept and clean ahead of the tack application (*Standard Specifications* Section 5-04.3(5)A). The tack coat should be broken and cured prior to allowing construction traffic on it, and must be broken and cured before HMA is placed on it. Remember that proper application of tack coat is essential to long life for the pavement.
5. Examine the pavement base, and verify that all required patching and/or pre-leveling is completed. Verify the planned surfacing depths before paving begins.
6. If the paving Contractor elects to use control wires for grade control, verify they are to the correct grade and are adhered to during the paving operation (*Standard Specifications* Section 5-04.3(3)C).
7. Check transverse joints for smoothness and appearance (a straightedge should be used).
8. Watch trucks dumping into paver hopper or transfer device for adverse effect on paver operation. Ensure a material transfer vehicle (MTV) or material transfer device (MTD) is being used if required. Pay particular attention to constant uniform paver speed and minimum operation of the hopper wings. If a transfer vehicle is not used or the hopper wings are being folded, the Street Inspector should check for significant temperature differences on the paved mat prior to compaction. These temperature differences can lead to non-uniform compaction.

9. Check temperature of HMA occasionally and watch for evidence of incomplete mixing.
10. Maintain constant inspection of the mat behind the paver for signs of roughness or non-uniformity of mixture.
11. Ensure the longitudinal joints are raked and compacted properly. The Contractor should be doing minimal handwork with a rake and should only "bump" the material at the joint and stay away from "raking" the material.
12. Make frequent checks of yield and depth.
13. Watch the rolling operation and verify that the rollers are operated in accordance with the manufacturers recommendations (*Standard Specifications* Section 5-04.3(4)). See that nuclear density readings are maintained. Check the internal temperature of mix to verify that static rolling is used when the mat temperature is below 175°F.
14. Keep a record of truckloads used each day.
15. Make sure the job is in good shape and safe for traffic before you leave at the end of the day, that the transverse night joint is properly constructed (*Standard Specifications* Section 5-04.3(12)A1), and that any excess paper is trimmed from the transverse night joint.

Duties Before Paving Begins

The Street Inspector is a key participant in the prepaving meeting and typically oversees all aspects of the operation at the jobsite. The Street Inspector should be knowledgeable as to the project limits, hours of operations, the direction in which paving is to proceed, methods of performing any unusual features of work peculiar to the project, proposed traffic control methods, etc. The plan of operation agreed upon at the prepaving meeting should be followed faithfully whenever possible.

Traffic Control – The Contractor shall conform to the requirements of *Standard Specifications* Section 1-10. The Project Engineer and the responsible Inspector must work closely with the Regional Traffic Engineer and the Contractor to ensure that the proper signs are placed in the best possible manner. All applicable signs shall be installed on the job before paving begins.

Inspection Tools – Before paving work begins, the Street Inspector must verify that all tools and equipment necessary for the inspection work are available. These would include such things as surface and probe thermometers, tape measure, depth gauge, 10-foot straightedge, notebooks, Inspector's Daily Report, report forms, etc.

Inspection of Paving Equipment – It is the duty of the Street Inspector to inspect the Contractor's paving equipment to verify the equipment meets the Contract Specifications. For the best possible surface finish, it is essential that all machines are in good condition and all parts are in proper adjustment. All equipment, including trucks, should be observed for hydraulic and fuel leaks when systems are under pressure. If leaks are detected, notify the Contractor immediately to clean up the leaks and repair or remove the equipment creating the leaks.

Listed below are some of the most important details the Street Inspector should check during the inspection of paving equipment:

(a) **Paving Machines** – Several types and makes of paving machines are in use in this State, all of which are capable of producing satisfactory surface finishes. The differences between types of paving machines are primarily in the methods used in striking off, compacting, and smoothing the mixture. The Street Inspector should be familiar with the mechanical features of the type of paver to be used on each job. Handbooks of operating instructions are available from each manufacturer, in which the various adjustments and operating details are shown. The Street Inspector can obtain copies of these instructions from the Contractor or the manufacturer if needed. The requirements for paving machines are in *Standard Specifications* Section 5-04.3(3). Ask the Contractor to explain the operation of the attachment intended to construct the notched wedge joint. The Street Inspector must be familiar with these Specifications.

Extensions may be added to the paving machine to allow the Contractor to pave a wider section. When the extensions are used in the traveled way they are required to have augers and screeds that vibrate and are heated. Most paving machines will be equipped with automatic screed extensions.

On all track paving machines, correct adjustment of the track linkage is essential for smooth operation. A poorly adjusted track, or a badly worn one, can produce an uneven, lurching movement in the travel of the machine which will be reflected in an uneven, "choppy" pavement surface. Observation of the machine in motion will usually show up any defects in the track or drive mechanisms.

Some pavers are suspended on rubber-tired wheels. For proper operation of this type of paving machines all tires must be inflated to the correct pressure and the drive system must not have any slack.

The paving machine is required to be equipped with the most current equipment available for the prevention of segregation and the Contractor is required to provide a certification, upon the Street Inspector's request, that it is properly equipped.

(b) **Rollers** – The proper operation of the roller is a key factor in quality pavement. When done properly the HMA will be compacted to a dense uniform mat free of defects. Improper operation produces a poor quality mat that may include tears, roughness and low or uneven compaction. All of these will result in a reduced life of the HMA and increased long term cost to WSDOT.

The Street Inspector should be especially watchful for flat spots on the drums of steel rollers. The steering and driving mechanisms must be free of excessive play or backlash. Observation of the roller in motion and reversing direction will disclose any deficiencies in the drive and clutch mechanisms. The manufacturer of the roller provides the maximum rate of travel.

Pneumatic-tired rollers, to function properly, must have tires of equal size and in good condition. All tires must be equally inflated, so that all exert equal unit pressure on the pavement. Tire pressures may be varied to suit conditions on the job, but, in general, should be such that ground contact pressures range between 40 and 80 psi. The Street Inspector should observe the roller in motion to see that all wheels are rolling true, without wobble or creep. Pneumatic tired rollers should have full skirts as the tires must be warm to prevent "picking." (When the cool tires roll over the hot HMA mix, the mix tends to stick to the tires, and is "picked" up from the mat onto the tires.)

Current vibratory rollers are capable of operating in three modes: static, vibratory, and oscillating. In static mode, the only movement of the drum is rolling on the pavement. In vibratory mode, eccentric cams inside the drums add rapid movement of the drum that is primarily up and down. In oscillatory mode, eccentric cams inside the drums add rapid movement of the drums that is primarily forward and back. An individual drum can operate in only one mode at a time but it is possible for a roller to operate the front drum in a different mode from the back. Compaction on a bridge deck is allowed with drums in either static mode or oscillatory mode – vibratory is not allowed. The Street Inspector cannot see the difference between vibratory and oscillatory by looking at the drum because the movement is too rapid. The only way to tell whether a drum is vibrating or oscillating is to learn how to read the control panel by discussing it with the roller operator. Each roller manufacturer has a different control panel. A pre-pave meeting is the ideal time for the Street Inspector to view the controls and discuss how to best ensure oscillation or static mode on bridge decks.

(c) **Other Items** – The Street Inspector should be satisfied that the Contractor is properly equipped with portable barricades, cones, or other means of protecting the freshly laid pavement from damage by traffic.

Upon completion of the check of the paving equipment, the Street Inspector should call any deficiencies of equipment to the attention of the Contractor, so that correction can be made.

Preleveling – The Project Engineer must give careful consideration to the use of a preleveling course over areas of unusual roughness, wheel ruts, or sags in the profile of the pavement base. The Contractor should be given as much advance notice as is possible of the intent to place a preleveling course. The areas that need prelevel should be marked out and reviewed with the Contractor prior to the pre-pave meeting. The extent of prelevel and the methods to be used should be discussed at the pre-pave meeting.

There are several methods the Contractor is allowed to use for preleveling. One method is the use of a motor grader. A paving machine may be used if better results can be obtained by this method and particularly where long undulations occur. When conditions warrant, a reference line may be erected for preleveling and an electronic paving machine reference should be used for placement of subsequent pavement courses. Ruts can be economically preleveled by dragging a paver screed if the Contractor elects to use this method. In order to outline areas and amount of preleveling, the Contractor may elect to erect a single reference line along the crown point for the first pass. The practice of directly marking depths and limits of preleveling required on the pavement surface is considered beneficial. When the area is small or irregular the Contractor may choose to use hand methods to prelevel.

The nominal compacted depth of any layer of any course, including preleveling lifts, shall not exceed the depths outlined in the *Standard Specifications* for the class of mix being used. The purpose of this requirement is to reduce the differential compaction that takes place and to ensure adequate compaction of thick lifts between two humps. Compaction of pre-level should be accomplished with a pneumatic roller. When preleveling wheel ruts, a pneumatic tire roller is required.

To produce a satisfactory riding surface, preleveling, in theory, should continue regardless of plan quantities until a uniform lift of HMA can be placed by paving machines with the electronic reference. If it appears that the plan quantity of prelevel must be exceeded due to the condition of the existing pavement, the situation should be immediately brought to the attention of the Project Engineer and the Region Construction staff. The Project Engineer must take care to clearly distinguish between preleveling operations and paving operations, especially for lifts under wearing courses.

Duties During Paving Operations

Prior to beginning of paving work each day the Street Inspector must verify that grade control lines, if used, are set for the day's work, that the base is properly prepared, and that tack coat has been adequately and uniformly applied through the area (including vertical edges) to be paved during the day. It is not a good practice to apply tack coat over more area than can be paved in a day or an hour or two if the weather appears to be questionable. Traffic conditions may also dictate how far the tack coat should be placed ahead of the paving operation.

Miscellaneous Duties of the Street Inspector

Prior to placing HMA against gutters, curbs, cold pavement joints, manhole castings, etc., the Street Inspector must verify that all contact surfaces are painted with an accepted tack coat.

A detailed Inspector's Daily Report (DOT Form 422-004, 422-004A, and 422-004B) will be kept by the Street Inspector, noting all unusual occurrences, orders received from the Project Engineer, orders issued to the Contractor, and other pertinent information.

The Hot Mix Asphalt Compaction Report (DOT Form 350-092) must be prepared by the Density Inspector.

Multiple Asphalt Plants

When two or more asphalt plants are used on one project, the mix from each plant must be placed with separate paving machines and compaction equipment. This is necessary because of the required adjustments on each paving operation to accommodate the different mixes and the various rolling patterns that may be necessary.

GEN 5-04.4 How to...

Compute Yield – During the paving operation, a careful record shall be kept, showing truckloads, the weight of each truckload and other pertinent data. Periodically, the Street Inspector is required to compute the quantity of mix placed per square yard, and must compare the yield against the proposed quantities. Overruns or underruns in quantities may be avoided by making a constant check of quantities placed.

HMA pavements are designed on a weight/volume relationship of 137 pounds for one square yard of pavement at a compacted depth of 0.10 feet. It is the intention in the construction of the pavement to spread the mixture according to an average yield in pounds per square yard.

Remember that the minimum compacted depth of pavement must also be met. If the aggregates are heavier than anticipated when the quantities were computed, or if the surface that the pavement is being constructed on is not true, the average yield can be attained without meeting the minimum thickness requirement.

Weigh tickets must be collected and a daily total weight of mixture received will be obtained and entered on the daily report for submission to the Project Engineer.
To eliminate possible errors, totals as recorded by the Plant Inspector shall be compared against the total obtained by the Street Inspector. Careful attention given to those details may save argument with the Contractor concerning pay quantities.

Determining Minimum Lift Thickness – On occasion, the thickness of an individual lift of HMA is not specifically indicated on the roadway sections, or a Contractor requests permission to place the HMA in more than one lift. Although maximum lift thickness is specified in the *Standard Specifications*, there is no guidance as to the minimum.

Lift thickness is governed by aggregate size. Adequate lift thickness ensures proper aggregate alignment during compaction, so that density and an impermeable mat can be achieved. Lifts placed too thin can lead to aggregate segregation, tearing, and more rapid cooling of the mat. It is generally more difficult to achieve proper density and pavement smoothness with a thin lift. As a guide, the following table may be used to determine the minimum lift thickness for the various classes of mix.

HMA Class	Minimum Lift Thickness (ft)
⅜"	0.08
½"	0.12
¾"	0.20
1"	0.25

SS 5-04.3 Construction Requirements

SS 5-04.3(3)A Mixing Plant

Plant Inspector's Checklist – Some of the most important details of inspection on asphalt plants are listed below:

1. Verify that testing tools, equipment, and samples are on hand at the plant site and in good condition. Make sure you understand all of the required tests.
2. Inspect all components of the asphalt plant listed in the *Standard Specifications*, and make sure all deficiencies are corrected *before* production has begun.
3. Verify that the truck scales are currently certified in accordance with *Standard Specifications* Section 1-09.
4. Post mix designs, including all revisions to the JMF. When a reference mix design is accepted the Inspector should verify if any changes to the mix design were accepted on another Contract.
7. Watch for evidence (dark smoke from plant exhaust and oily coating of aggregate) of incomplete combustion of burner fuel.
8. Check frequently the temperature of the asphalt.
9. Observe plant operation occasionally to verify that correct weights and proportions are obtained, including asphalt content and recycled asphalt pavement (RAP).
10. Make frequent visual inspections of mix leaving the plant for evidence of non-uniformity or incomplete mixing.

11. Check temperature of mix frequently. The mix design has the temperature requirements. An infrared heat gun may be used.
12. Inspect truck beds before loading and verify that the bed is free of congealed chunks of mix and excess release agent.
13. Observe the Contractor taking samples of aggregate before mixing with asphalt, and HMA mixture, for acceptance testing and submission to the laboratory.
14. Make accurate, complete record of all test results, asphalt used, and other pertinent data.
15. Have copies of all test reports available for review.
16. Fill out the required daily reports.
17. Keep in constant communication with the plant foreman and the Street Inspector and give immediate notification regarding any problems.

Acceptance Testing – On all projects involving HMA, job site samples shall be obtained, tested, and recorded in accordance with the *Standard Specifications*, the Contract Special Provisions, and Chapter 9 of this manual. A split of the field sample will be retained by the field tester for further testing if necessary. This sample may be used when the Contractor requests a sublot be retested in accordance with *Standard Specifications* Section 5-04.3(9) B7. Asphalt content of the mix shall be determined by use of the Ignition Furnace in accordance with WAQTC FOP for AASHTO T 308, gradation determined in accordance with WAQTC FOP for AASHTO T 30, and voids in mineral aggregate (VMA) and air voids (V_a) in accordance with WSDOT SOP 731.

Samples Required by Materials Laboratory – Mix design "conformation samples" are not used for acceptance so they impose no liability risk to the Contractor. Conformation samples are samples that shall be submitted to the State Materials Laboratory Bituminous Materials Section. For all projects, beginning with the first acceptance sample, submit one sample (two representative quarters) every 10,000 mix tons (one conformation sample for every ten acceptance samples). The conformation samples should be taken in conjunction with and be representative quarters of the acceptance samples taken for the project as described in WSDOT Test Method 712. When taking a sample for mix design conformation testing, a sufficient quantity of the mix should be obtained so that two representative quarters of the same sample are submitted to the State Materials Laboratory. Samples shall be taken as provided in Chapter 9.

Sampling Methods – Samples of the complete asphalt mixture should be taken by the Contractor, at the request of and in the presence of the Plant Inspector, in accordance with WAQTC FOP for AASHTO R 97. Acceptable locations are either by mechanical sampler between the discharge of the silo and the haul truck if approved by the Regional Materials Engineer, or from the truck without entering the truck. The Plant Inspector should then reduce the sample to size for testing in accordance with WAQTC FOP for AASHTO R 47. Remember that the value of material quality testing is dependent on exact parallel tests of identical splits from representative samples.

Verification of the Ignition Furnace Calibration Factor – The State Materials Laboratory prepares 12 ignition furnace calibration samples for every HMA mix design. Four samples are shipped to each Region along with the reference HMA mix design so they can calibrate their ignition furnace. The "Ignition Furnace Calibration Factor" shall be determined in accordance with WSDOT SOP 728 and should be done prior to beginning the production of any paving mixture using initial mix design.

The verification shall be done using the furnace that will be used for acceptance testing. In some circumstances it may be necessary to use production data to verify acceptance results but should be only utilized when all verification procedures have been used and validated.

Inspection of Mixing Plant

Plant Inspectors should familiarize themselves with plant operations prior to beginning of paving. A visit to the plant will do this and additionally provide an opportunity to inspect the plant for conformance to *Standard Specifications*. Specification violations should be brought to the attention of Contractor so they may be corrected prior to beginning paving.

When doing plant inspection, particular attention should be given to examination of gates, feeders, drier and dust collector, screens and bins, pugmill, and all thermometers, pyrometers, and weighing scales. To assist in this inspection, one of the previously recommended hot mix asphalt paving handbooks will provide excellent guidance.

With the increased emphasis on aggregate structure, voids in mineral aggregate (VMA) and air void content (V_a), it may be necessary for the Contractor to use multiple stockpiles.

Allowable methods of heating the asphalt are stated very clearly in the Specifications, and the limits of the range of application temperatures are also specified. An asphalt thermometer is required to be installed in the asphalt line. This thermometer should be checked for accuracy before work starts. Close control of variations in temperature of the asphalt binder is very important, as overheating of asphalt oils will cause hardening and may cause substantial decrease in pavement life. The Project Engineer may allow increasing the mixing temperature, in accordance with the manufacturer's recommendation, as allowed in the *Standard Specifications*.

Standard Specifications Section 5-04.3(3)A Item 1 requires that a valve be placed in either the asphalt supply line to the mixer or the storage tank for sampling the asphalt binder. This valve should provide a safe method of obtaining samples of the asphalt binder that are representative of the material being incorporated in the mixture. All samples must be taken by the Contractor in the Plant Inspector's presence. If for any reason the asphalt binder is suspected to have become mixed or contaminated in the storage tank, additional samples from the asphalt supply line should be taken and noted on sample submittals.

Inspection During Mixing Operations

After the mixing begins and throughout the day, the Plant Inspector, who is a qualified tester, shall perform the required tests of the HMA mixture. It is very important, however, that the testers spend some of the time observing the operation of the plant and the condition of the mixture being produced. Changes in the mixture can quickly be detected by observing changes in appearance or color of the mixture.

Periodic checks of the temperature of the liquid asphalt, as well as the mixture produced must be made to ensure that maximum allowable temperatures are not exceeded and uniform material is being produced. The Contractor will choose the desired temperature of the mixture within Specification limits, depending on weather conditions, length of haul, and other factors. Plant Inspectors should watch for excessive variation in temperatures, and notify the Contractor of any variation that occurs. Variable temperatures of the mix may cause compaction and segregation problems; therefore close monitoring of temperatures is an essential part of HMA paving.

When stockpiled, aggregates may contain a high percentage of moisture. With excess moisture in the aggregate difficulty may be encountered in heating the material to the proper temperature. In some cases, the Contractor may try to correct this condition by increasing the amount of fuel oil fed to the burner. This can be done satisfactorily until incomplete combustion of the fuel oil occurs. Black smoke coming from the exhaust stack is an indication that incomplete combustion is occurring. Black smoke is also a sure sign that air quality standards are being violated. The Plant Inspector should watch for this condition, as the unburned fuel can deposit a sooty, oily film on the aggregate particles that is detrimental to proper coating of the material with the asphalt film. A reduction in the rate of aggregate fed to the drier will usually correct the situation and allow proper heating and drying of the material.

Frequent inspections of the condition of the mixture leaving the plant should be made, noting the consistency of the mix, the distribution of asphalt and aggregate throughout the mixture, and the temperature of the mixture. Trucks should be loaded by multiple dumps of three or more as recommended by the National Asphalt Pavement Association (NAPA). If the quality of the mixture varies from truck to truck, an immediate check should be made to locate the source of trouble. Uniform distribution of asphalt binder throughout the mix is extremely important. If portions of each truckload vary from rich to lean, the Plant Inspector must advise the Contractor to correct the problem. It may be necessary to increase the mixing time to correct this situation. By examining the mixture in bright light, the experienced Plant Inspector can quickly detect non-uniformity in the mixture.

Miscellaneous Duties of the Plant Inspector

One of the duties of the Plant Inspector may be to oversee the work of the scale person on truck weighing scales at the plant, and verify that the required tests of the scales are performed. The Plant Inspector must verify that tickets are properly made out and issued for each truckload of mixture delivered, and must also verify that daily totals are promptly obtained and entered on the daily report. When HMA is produced using a warm mix asphalt (WMA) process the tickets are required to identify the mixture as WMA.

Before trucks are allowed to be loaded at the plant, a check shall be made to verify that the truck beds are properly lubricated as required in the Specifications. No pools of bed release agent shall be allowed to remain in the truck bed following this operation. The truck bed should be raised to allow any excess material to be drained off.

When the Contractor is using a site furnished by WSDOT, the Plant Inspector should ensure that the Contractor shapes up any remaining aggregate into neat stockpiles, and removes all debris from the plant site when the project is complete.

SS 5-04.3(3)D Material Transfer Device or Material Transfer Vehicle

Material Transfer Devices (MTD) and Material Transfer Vehicles (MTV) are machines used between the delivery trucks and paver. An MTD is attached to the paver while an MTV is self-propelled and not attached to the paver. These devices/vehicles provide for remixing of the HMA prior to placement which brings the HMA mixture to a more consistent temperature. This will greatly reduce or eliminate “cold spots” in the mat when the HMA is placed. In addition, the use of these machines will allow for a more constant operation, minimizing stops and starts. This will provide a smoother mat.

At the Contractor's request the Project Engineer may approve paving without a Material Transfer Device or Materials Transfer Vehicle (MTD/V). It is intended that these request be approved for work at intersections, etc. These requests will not be approved if they reflect work on mainline paving. The Project Engineer should evaluate these requests for equitable adjustments in monies or time.

SS 5-04.3(4) Preparation of Existing Paved Surfaces

Proper application of tack is one of the most important construction processes for ensuring the full service life of the pavement. Too much tack, too little tack, streaks, or failure to allow time for the tack to break before being covered with hot mix can reduce the pavement life by half or more.

The Specifications require an application of tack coat that is uniform and free of streaks and bare spots. The application rate will depend on several factors and include the condition of the existing pavement, the Contractor's equipment, the type of asphalt used, if it has been diluted with water and the application temperature. Tack coat is always applied to all paved surfaces prior to the placement of HMA including projects that have multiple lifts of HMA. Tack coat is not required when HMA is placed directly on crushed surfacing. For many pavements an application rate of approximately 0.05 gallons per square yard of residual asphalt is adequate. When paving a second lift of HMA a lower application rate is typically applied. Thin lifts of pavement require heavier applications of tack coat to prevent raveling, spalling, and delamination. As a guide, existing surfaces that are coarse, dry or milled require a higher application rate of tack coat than surfaces that appear rich or bleeding.

SS 5-04.3(4)B Soil Residual Herbicide

Weeds cause considerable damage to thin asphalt pavements such as sidewalks, shoulder overlays, and asphalt lined ditches. It is typically recommended that chemical weed control be used under all asphalt pavements less than 0.35 feet in depth unless a full depth base preparation was included in the construction. Check the Contract requirements to see if soil residual herbicide is required.

SS 5-04.3(7) Spreading and Finishing

In the construction of HMA pavements, it is extremely important for the paving machine to be in good adjustment and the machine and screed operators be experienced and capable. The Street Inspector should be quick to note operational practices that have an adverse effect on the work, and *request* the Contractor to make immediate corrections.

Compaction procedures will be as specified in *Standard Specifications* Section 5-04.3(10).

During the paving operation, constant inspection must be maintained to see that the machine is producing a smooth pavement having the required characteristics of texture and uniformity. The Street Inspector must require immediate action be taken by the Contractor to correct any trouble that may develop.

Listed below are some common difficulties encountered on HMA paving work, together with the most common causes of the difficulty:

- **Wavy Surface (short, choppy waves)** – Worn or poorly adjusted tracks or drive train; truck driver setting brakes too tightly; excessive paving machine speed; vibratory roller operating too fast.

- **Wavy Surface (long waves)** – Excessive variation in amount of mix carried in auger box ahead of screed; over-controlling screed; milling machine operated too fast.
- **Excessively Open Surface Texture** – Improper adjustment of strike off; screed plate surface is rough or galled; excessive paving machine speed.
- **Varying Surface Texture** – Insufficient mixing; trucks being loaded improperly at the plant; segregation of mix in trucks; poor gradation control at mixer; screed not uniform across paving machine.
- **Streaked Surface Texture** – Insufficient mixing; segregation of mix in trucks; worn or damaged screed plate.
- **Bleeding Patches on Surface** – HMA not uniformly mixed; excessive moisture in mix, or high binder content in the mix.
- **Irregular Rough Spots on Pavement** – Roller standing on fresh surface; abrupt reversing of roller; trucks backing into paver; poor workmanship at transverse joints.
- **Cyclic Open Texture or Mat Temperatures that Vary More Than 25° (that usually matches up with the distance that each truck load of material covers)** – This may be caused by a couple of problems. One is the result of thermal segregation. In this case, the differential temperatures in the HMA result in inconsistent compaction and a cyclic open texture. The use of an MTV/D will reduce or eliminate thermal segregation. Secondly, the machine operator may be allowing the head of material to fall below the top of the augers or by dumping the wings of the paver when the hopper is low on material. Hopper wings should be operated only occasionally and then with some load in the hopper.
- **Crooked or Irregular Longitudinal Joint Lines** – Careless machine operation or no guide string placed for the machine operator to follow.

Some paving machine operators have a tendency to operate the paver at speeds in excess of that required to handle the quantity being produced at the plant, resulting in a jerky, stop and go operation. *This must not be allowed.* Generally, when the paver is operated consistent with plant production and roller capacity, the finished surface will be smoother. The ideal speed of the paver will be that which will result in a smooth, nearly continuous process with a minimum of stops required in waiting for trucks and/or the compaction equipment. If the production rate of the mixing plant is very high, requiring excessive speed of the paver, the Contractor will be required to correct the situation by slowing the production or using additional paving machines and generally, additional compaction equipment. Delivery must be adjusted to match production and uniform lay down.

The Street Inspector should periodically check for difficulties while truckloads of mixture are dumped into the hopper of the paving machine. Trucks must not be allowed to back into the paver in such a manner that they bump the paver, nor shall trucks that bear against any part of the machine other than the pushing rollers be permitted to dump into the paver. Any mix spilled onto the pavement in front of the paving machine must be shoveled into the hopper of the machine or back into the truck before paving is resumed. The Street Inspector should be especially watchful to see that mix spilled in the paths of the tracks or wheels of the machine is removed.

Checks should be made of the crown adjustment of the screed, to ensure that the finished surface will conform to the required section.

Particular attention must be given to the construction of the longitudinal joint when paving adjacent to a previously laid lane. The Street Inspector must insist that hand raking be held to a minimum, by adjusting the screed so that the freshly laid pavement is of the proper depth, allowing for compaction, to meet the grade of the previously laid lane. The uncompacted mixture immediately adjacent to the joint should be left slightly high so that the roller can compact the mixture thoroughly at this point. The rakers must not be permitted to cast excess mixture over the uncompacted, freshly spread lane. The Street Inspector must insist that segregated coarse particles of mix remaining after making the joint be removed and wasted, to avoid construction of a coarse, porous joint.

GEN 5-04.3(9)B3 Mixture Statistical Evaluation – Acceptance Testing

Beginning with the 2018 paving season, several changes to Specification requirements for HMA compaction and mixture are being phased in incrementally over four years. The goal of these changes is to increase the service life of our HMA by at least one year. We are implementing these changes incrementally over four years to provide time needed by Industry to adjust means and methods to successfully meet the new requirements.

Changing Specifications so frequently creates a challenge for staff responsible for entering and evaluating HMA test results, making sure that HMA data is being evaluated in accordance with each Contract, and ensuring that incentive/disincentive payments are being made per Contract. Offices administering multi-season HMA projects could be dealing with as many as three different Specifications in one paving season, until 2023.

The key to ensuring that you are following the correct Specification when performing statistical evaluation and making the incentive/disincentive payments is to make sure the settings in SAM are correctly set to match the requirements of the Contract. It is easy to see what the SAM setting for HMA evaluation is for a particular Contract by looking at what is indicated in the drop-down list for "Material". For example, if the material drop-down list shows "Class ⅜ inch, 9-03.8(7) – 2018", SAM is using what is referred to as the 2018 settings. A drop-down indicating "Class 3/8 inch, 9-03.8(7) – 2019" indicates the 2019 settings are being used, and so on.

The difficulty arises in determining which "year" in the "Material" setting is required by your Contract. It is not the Specification book year, because these changes have been made by Amendments and in some cases by Special Provision. The only way to correctly determine if SAM is correctly performing the statistical evaluation on your HMA is as follows:

1. Find the values in your Contract for each of the Specifications listed in the table below. Be sure to look in the Amendments to the *Standard Specifications* and in the Special Provisions to see if any changes have been made to the *Standard Specifications*.
2. Compare the values in your Contract to those in the table below. Find the column in the table below that exactly matches all the values in your Contract. Find the Specification year at the top of that column. If your Contract does not exactly match all of the values in one of the columns, contact your ASCE in the State Construction Office.
3. Look at the "Material" drop-down list in SAM. The Specification year indicated by SAM must be the same as the one you determined from your Contract and the table below. If they do not match, change the SAM pic-list item so it matches the Specification year determined from the Table.

Field Acceptance – HMA Spec Changes: Mixture and Compaction

SPEC	SPEC REQUIREMENT	2016	2018	2019 & 2020	2021 & 2022
9-03.8(7)	VMA Tolerance	N/A	-1.5%	-1.0%	-0.5%
9-03.8(7)	Binder Tolerance	-0.5% to +0.5%	-0.4% to +0.5%	-0.4% to +0.5%	-0.4% to +0.5%
2016: 5-04.3(10)B1 2018 & 2020: 1-06.2(2)D5 2021: 5-04.3(10)C3	Compaction Lower Spec Limit - disincentive	91.0	91.0	91.5	92.0
2016: 5-04.3(10)B1 2018 & 2020: 1-06.2(2)D5 2021: 5-04.3(10)C3	Compaction Lower Spec Limit - incentive	91.0	91.5	92.0	92.0
2016: 5-04.5(1)B 2018 & Newer: 5-04.3(10)C3	Compaction Price Adj. Factor - Disincentive	0.40	0.40	0.60	.40
2016: 5-04.5(1)B 2018 & Newer: 5-04.3(10)C3	Compaction Price Adj. Factor - Incentive	0.40	0.80	1.00	1.00

SS 5-04.3(10) HMA Compaction Acceptance

SS 5-04.3(10)A HMA Compaction - General Compaction Requirements

Compaction of the HMA is very important in the construction of a durable pavement. When good compaction is coupled with the proper mix design, extended service life of the pavement can reasonably be expected.

The importance of thorough compaction of HMA cannot be over stressed. Two major factors are working simultaneously in a well-designed mixture to resist good compaction: (A) the stability of the mix in place increases with each pass of the roller, and (B) the viscosity of the asphalt increases as the temperature drops. A temperature-viscosity curve for the type of asphalt used in the mix is a useful tool in determining the ideal compaction temperature of the mix.

Although densities for some HMA may be increased at temperatures below 175°F, vibratory rollers may damage the mat internally in ways that cannot be seen at the time of compaction. To prevent this damage, compaction with static rollers is required when the internal temperature of the mix is below the minimum Specification of 175°F. When paving in air temperatures over 90°F, some or all of the compactive effort may have to be delayed, but in no case should it be delayed below 175°F mat temperature.

Vibratory rolling is prohibited on bridge decks and within 5 feet back of the pavement seat, however, rollers may be operated in oscillatory mode unless otherwise noted on the plans.

The desirable end product of a properly compacted HMA is a dense and nearly impermeable mat. Acceptable densities can be obtained if the mix proportions are proper. If not, no reasonable amount of compaction can produce acceptable density. Without proper density, the HMA will be subject to early distress and failure. Some mixes may be difficult to compact because they will move under the roller instead of compact. This is referred to as a tender mix and may result from several causes including gradation, fracture and asphalt binder properties.

The asphalt binder content in a mix is based on several factors including traffic levels, aggregate structure and asphalt binder properties. The Contractor develops the mix design to meet specific volumetric properties. Field changes in the mix design asphalt content should only be allowed after careful consideration of all of the impacts. The maximum adjustment the Project Engineer may allow may not exceed 0.3 percent from the accepted mix design (*Standard Specifications* Section 9-03.8(7)). The Region Materials Laboratory is a good resource when considering changes in the asphalt binder content. Increasing the asphalt binder content on high traffic volume routes carries more long term performance risk than on low volume roads.

The use of thicker lifts of pavement permits more time for compacting and will increase the effectiveness of the equipment. With careful organization and planning, the production of over 400 tons per hour may be compacted by as few as three rollers on deeper lifts. It is also apparent that high production rates with thin lifts might require twice as many rollers or more. It is the Contractor's responsibility to determine how many rollers are needed to match the asphalt plants production rate.

Usually the Contractor has a companion group of rollers, pavers, and production equipment for use together on paving projects that have been proven to be compatible.

Before production begins, the Region Materials Engineer should be notified to arrange for the coring of the pavement to correlate nuclear densities to core densities for calculation of a nuclear gauge correlation factor, and to core bridge decks for compaction if the Contract assigns these cores to WSDOT.

In general, compacting should begin on the outer edge of the course and progress toward the center of the pavement except on superelevated sections where the initial effort shall be on the lower side with the progressive compaction toward the higher side.

The type of rollers and their relative position in the compaction sequence shall generally be at the Contractor's option provided Specification densities are attained and it is not specified otherwise in the Contract Provisions. Exceptions are (1) a pneumatic tired roller is required for compaction of the wearing course from October 1 through March 31, and (2) a pneumatic tire roller is required to compact preleveling in areas that are severely wheel rutted. Coverage with a vibratory or steel roller may precede pneumatic tired rolling. The maximum speed of rollers shall not exceed the recommendations of the manufacturer of the roller for the compaction of HMA. When requested by the Project Engineer, the Contractor is required to provide a copy of the manufacturer's recommendations. When the roller reverses direction the vibrators must be turned off momentarily.

The steel drum vibratory roller is generally used for the primary compaction on HMA mixes and sometimes for finish rolling in a static mode. Two terms frequently used with vibratory rollers are frequency and amplitude. Frequency is how often the impacts are applied and is normally stated in cycles per second. Amplitude is the greatest vertical movement, up or down, of the drum during a cycle.

Vibratory rollers achieve their compaction effect from the kinetic energy produced by the vibrating components of the roller. Vibratory rollers usually work best when operated with high frequency and low amplitude on dense graded leveling and wearing courses. On hills, it usually works best to operate the vibrators only while traveling uphill. Over vibrating can cause a decrease in compaction. Operated in the static mode, despite their apparent bulk, they are less effective than even intermediate size conventional steel drum rollers due to their lower mass.

Vibratory rollers may not be practical in areas where there are mortar joint concrete or certain other vintage pipe used for utilities or irrigation. In locations with this type of pipe the Special Provisions will restrict the compaction to static rolling.

With pneumatic roller breakdown it will be necessary to hold in about 6 inches from unsupported edges to avoid lateral displacement of the HMA. A narrow overlap of successive trips is desirable and the roller should be kept in constant motion. During initial compaction, the rollers orientation should be such that the powered axle passes over the uncompacted mix first. Breakdown tiller wheels should be turned the least possible amount in the uncompacted area to avoid pushing and shoving the hot mat near the wheels. The steel drum roller should follow closely behind the pneumatic roller to compact the centerline joint and the edge of the pavement as well as iron out the pneumatic tire marks. The steel drum roller will exert extra pressure on the uncompacted edge and should have no difficulty in properly compacting this edge if the roller is close behind the pneumatic rollers. Cold rubber tires usually "pick" the mat. Every effort should be made to warm the tires before compacting the mat. Sending the rollers for a drive before the work is fully organized prior to paving will help with the tires.

The axles of the roller are weighted by the use of iron pigs, chain, rivets or other concentrated loading in addition to the usual water and aggregate tank loading to control the total roller weight. Ground contact pressure is determined by the tire inflation pressure, a ground contact pressure of 70 psi is a reasonable pressure to start with. Variation in the mixture and tire pressures will soon determine the most desirable combination of mixture, temperature, contact pressures and number of applications.

Steel drum rolling is generally used for finish rolling; however, it is sometimes used for breakdown and primary compaction. It is important that vibratory roller operation on pavement with temperatures below 175°F not be permitted. Over-rolling by the steel drum roller may damage the pavement more than under-rolling.

Preferably, rolling equipment should be wide enough so that a uniform application of compactive effort can be distributed over the entire course without creating hard streaks or leaving narrow porous strips. Breakdown and intermediate rolling should be completed while the mixture is above 185°F with the finish rolling completed above 150°F. With lower temperature mixes and thin lift applications it becomes obvious that the rollers must be kept up close to the paver.

SS 5-04.3(10)B HMA Compaction – Cyclic Density

Temperature variations in the newly placed HMA mat have the tendency to cause variations in density. These variations are more common when the HMA is dumped directly into the paver hopper, where there is limited re-mixing of the HMA to provide a consistent temperature. The requirement to use an MTV/D allows for re-mixing of the HMA, providing a more constant temperature as the HMA is being placed, reducing or eliminating the temperature variations in the mat behind the paver screed.

The Street Inspector should review the surface condition of the mat after rolling to determine if there are any areas which appear coarse in comparison to the rest of the mat. These suspect areas should be noted and marked for testing with the nuclear gauge to verify the compaction requirements have been met. Another effective method of identifying suspect areas is to use an infrared surface heat thermometer or thermal imaging camera. The thermometer or camera scans must be performed behind the paver screed prior to compaction of the mat. Any areas that are excessively cooler than

the rest of the mat (25° or greater) need to be noted and marked for testing with the nuclear gauge.

Areas marked as suspect for low densities are to be independent from the required random density acceptance testing. Readings taken for cyclic density are to be reported separately from acceptance testing on WSDOT Form 350-170.

Each 500 foot section of the mat will be evaluated. If there are two or more areas with a density of less than 90 percent of reference maximum density within the section, a $500.00 price adjustment will need to be assessed.

SS 5-04.3(10)C HMA Compaction Acceptance - Statistical Evaluation

Refer to Table 14 in *Standard Specifications* 5-04 to determine which pavements are statistically evaluated for acceptance of HMA compaction. Note also that 5-04.3(10)C1 requires all HMA compaction on a bridge deck to be evaluated statistically, regardless of whether the HMA is in a lane, shoulder, gore, et cetera.

Refer to Table 16 in Standard Specification 5-04 to determine whether pavement density is measured by testing with the nuclear density gauge or cores. If density is measured on cores, Table 16 also shows what role, if any, the Contractor will play in taking the cores.

Determine the percent compaction for each density test by dividing the density into the maximum density (Rice Density) as determined by WSDOT SOP 729 when using the nuclear density gauge and WSDOT SOP 736 when using cores. Enter the data into the MATS program. Be sure that MATS and SAM are using the correct Lower Specification Limit (LSL) for compaction required by your Contract. See the table above, under GEN 5-04.3(9)B3.

The compaction results are then evaluated statistically for acceptance by the SAM program. SAM calculates a CPF. If the CPF is greater than 1.00, the Contractor will receive an incentive payment for exceeding the minimum statistical requirements. If the CPF is less than 1.00, the Contractor will provide WSDOT a credit (a “disincentive”) for failing to meet minimum statistical requirements. If the CPF is equal to 1.00, the Contractor will receive neither incentive payment nor disincentive credit, because 1.00 represents “meeting” the statistical requirements.

Compaction lots not meeting the prescribed minimum CPF of 0.75 will need to be evaluated for removal and replacement with satisfactory material.

GEN 5-04.3(10)C1 HMA Compaction Acceptance – Statistical Evaluation

HMA density on bridge decks will always be determined using cores, and acceptance of HMA compaction on bridge decks will always be by statistical evaluation. When taking a core on a bridge deck, care must be taken to avoid damaging the concrete deck or waterproofing membrane. To mitigate any possible damage to the membrane or concrete deck, the bottom of the core hole must be swabbed with PG grade asphalt binder before backfilling the core hole with HMA.

WAQTC FOP for AASHTO T 355, regarding using the nuclear density gauge, requires all HMA density testing to be done with a thin lift gauge, or if one is not available, by using the backscatter mode.

SS 5-04.3(10)D HMA Compaction - Visual Evaluation

Visual evaluation is the basis for acceptance of compaction for preleveling and pavement repair. Refer to Table 14 in *Standard Specification* 5-04. For preleveling mix, the compaction control shall be to the satisfaction of the Project Engineer. A pneumatic tired roller is required for compacting HMA that is used for preleveling wheel rutting.

SS 5-04.3(10)E HMA Compaction - Test Point Evaluation

For any condition that does not require either statistical evaluation for compaction or visual evaluation for compaction, the Contractor shall construct a test point in accordance with instructions from the Project Engineer. The number and timing of passes with an accepted compaction train, that will yield maximum density with the nuclear gauge readings at the test point, shall be used on all succeeding paving. The Street Inspector should make sure the Contractor is making the required number of passes and reconstruct a new test point if conditions change. When this evaluation is used to determine density, WSDOT Form 350-073 is to be completed for project records.

In order for HMA to be accepted by a test point evaluation the Project Engineer shall, at the beginning of paving, select a section approximately 200 feet long upon which to conduct the evaluation. Select a spot within the section near the center of the pavement area for density testing with a nuclear density gauge. After each roller pass, a density reading is taken with the nuclear gauge at this test spot. Gauge readings are taken in the backscatter or thin layer mode; marking the footprint of the gauge with crayon or paint stick as there will be multiple tests required at the same location. Record the information required on DOT Form 350-073. Continue this process until the density readings level off or start to drop. This indicates the relative density has reached its maximum with the compaction equipment being used. After the relative density has reached the maximum, the Street Inspector may request the breakdown roller to make an additional pass or two to see if the density reading increases or stays the same.

The test section should be repeated when there is a change to the work. Examples of a qualifying change would be a different pavement section (depth of pavement/surfacing and not a different roadway section with the same structure), compaction equipment, mix design or JMF (JMF changes to the percent of asphalt binder or gradation).

When a Contractor is paving HMA which will be accepted by both statistical evaluation and test point evaluation in a single operation (e.g., lane and shoulder) the test point evaluation may be omitted if the Contractor uses the same rolling pattern on the area accepted by test point evaluation as that used for the statistical evaluation.

SS 5-04.3(12) Joints

SS 5-04.3(12)A1 Transverse Joints

The *Standard Specifications* provide that transverse joints, also called butt joints, be constructed. The use of heavy paper is recommended to form the butt joint at the end of the day's work, with a temporary ramp laid on the paper beyond the joint to assist traffic over the change in elevation. Paper protruding above the pavement shall be carefully trimmed flush with the pavement so that there will not be an illusion of a hazard at night. When the ramp and paper are removed prior to beginning the succeeding day's paving, a well-constructed joint will require a minimum of cutting back to form the required butt joint. When hand raking is performed on a joint, all segregated coarse aggregate shall be removed, to avoid a coarse, porous surface at the joint.

If the roadway is open to traffic, the transverse joint must be feathered to provide a smooth transition for the traveling public and joints between successive lifts in each lane should not be less than 100 feet apart. The higher the speed on the roadway, the longer the taper on the joint must be to provide an acceptable transition. The required slope ratio is 1 vertical to 50 horizontal or flatter.

This slope will usually require use of more than one width of paper. Sufficient material must be temporarily placed in front of the paver to prevent a deformation from occurring in the permanent HM the joint. Care should be taken to construct a straight line taper without humping.

At the beginning of the day's work, special care must be exercised in the construction of the transverse joint joining the freshly laid mixture with the previous day's work. The paver should be allowed to proceed at a low rate of speed (creep) ahead of the joint, until hand finishing of the joint is completed. The paver should not come to a full stop or the screed may settle and cause a dip at that point. The Street Inspector should check this work closely, using the 10 foot straightedge to see that the requirement for surface smoothness is met.

SS 5-04.3(12)A2 Longitudinal Joints

The long term performance of longitudinal joints is highly dependent on the quality of construction. Improperly and poorly constructed joints can fail prematurely; raveling and cracking are common problems with these joints. Proper joint construction includes the following:

- The joint is constructed at the lane line or an edge line of the Travelled Way;
- When multiple lifts of asphalt are placed a joint is offset from the joint below from 2 to 6 inches;
- Tack coat is applied to the joint, including the vertical face of the joint, to bind and seal the joint;
- Industry standards for compaction of the joint are followed to achieve density; and
- For a wearing course where new pavement abuts new pavement a notched wedge joint is required (unless otherwise approved by the Project Engineer).

A notched wedge joint has benefits by the shape of the joint in that there is a better bond, with tack, between the pavements and the density may be improved. This method of joint construction should be used in all locations in the wearing course; not using a notched wedge joint should be an exception and only allowed where the specific project conditions do not allow for this method of joint construction. A notched wedge is not required when new HMA is placed against existing HMA such as at the edge line of a grind and inlay project. The intent of the notched wedge joint is to partially confine the edge for paving while still leaving a "notch" to match to. The wedge needs to be adequately compacted and the notch needs to be there (i.e., not flattened or rounded by traffic or equipment driving across it) when the adjacent lane is paved.

When a roller is compacting HMA adjacent to a longitudinal joint the goal is to confine and densify the material at the joint. The sequence that is recommended by research on longitudinal joint construction is for the first pass of the roller that is adjacent to the joint to be approximately 6 inches from the joint on the "hot" side. This roller pass compacts and provides confinement for the HMA at the joint. This is followed with a roller pass that overlaps to the "cold" side of the pavement and the 6 inch strip of HMA is densified in the

joint area. Other methods of joint compaction have been demonstrated to push the HMA away from the joint resulting in lower density and poorer joint performance.

When HMA is placed adjacent to cement concrete pavement the joint is required to be sawed and filled with a joint sealant to prevent the intrusion of water.

SS 5-04.3(13) Surface Smoothness

When a course is being constructed below the wearing course, an attempt must be made to remove all depressions and sags in the grade line by adjusting the depth of the course. The Street Inspector should work closely with the screed operator to accomplish this result by pointing out irregularities in the base far enough ahead of the machine to allow proper adjustment of the screed to eliminate the irregularity. The objective to be attained during construction of each course is the complete elimination of all irregularities, so placement of the wearing course can be accomplished with a minimum of screed adjustments. If the base is excessively rough, pre-leveling should be completed prior to construction of the first course.

Standard Specifications Section 5-04.3(3)C requires the use of automatic screed controls on the paver. It must be remembered that as the equipment becomes more sophisticated, it also becomes more necessary that it be properly adjusted and operated or satisfactory results will not be achieved. With proper operation, this equipment will give excellent performance.

When reference lines are required, or the Contractor elects to use reference lines, particular attention must be given to verify the line is properly set and tensioned. If the line is offset too far from the paving machine, vibrations of the machine may affect operation of the automatic controls, which in turn affect the smoothness of the pavement. The reference line for asphalt paving machines normally will not be used when the roadway is under traffic. The Specifications provide that if the course the pavement is to be placed on is superior to established smoothness requirements, the paver may operate from a mat referencing device such as electronic sensors instead of the wire. The Street Inspector must ascertain that smoothness of the pavement continues to be superior to the requirements of the Specifications.

Normally, when the surface for paving is properly constructed using a reference line or the first course of pavement is constructed using a reference line, subsequent courses of pavement may be constructed using a mat referencing device with continued improvement in the surface smoothness.

Manual operation of the screed controls will be permitted in the construction of irregular shaped and minor areas, such as gore areas, road approaches, left turn channelization lanes, and tapers.

Surface smoothness and good ride qualities of a pavement are secured only by hard work and strict attention to small details. The Street Inspector should continually study the conditions peculiar to the job, and strive to obtain the smoothest surface possible. A smooth riding pavement costs no more than an unsightly, poor surface, but it does require constant, careful inspection of all details of construction to obtain the desired results.

Standard Specifications Section 5-04.3(13) outlines the smoothness requirements using a 10 foot straight edge oriented in both the longitudinal and transverse directions. Smoothness checks should be made at the starting point of paving, at transverse "night joints," whenever the paver is stopped for any length of time, or wherever the Street Inspector suspects a smoothness problem.

Some projects may include the "Smoothness Compliance Adjustment" pay item. The State Materials Laboratory Pavement Office will provide the beginning IRI results from the inventory lane of the previous year for informational purposes. The inventory data will not include data from all lanes. This data will be placed into the Contract for informational purposes.

After the paving is completed on the project, a specially equipped van will travel each lane to determine the final IRI. Payment for the "Smoothness Compliance Adjustment Factor" is determined from the pay schedule based on the type of roadway and associated opportunities to obtain smoothness.

See the General Special Provisions for more information. Ensure the proper usage of the Special Provisions and pay close attention to the intent of using the Smoothness Compliance Adjustment. It is not intended for short sections of paving, ramps or sections that have a speed limit less than 35 MPH. It is intended for mainline paving sections greater than 1 mile in length.

In order to measure the final IRI, the Project Office must inform the Pavement Office (MLPavementProfileTest@wsdot.wa.gov) and provide the form that can be found at http://sharedot/eng/cn/sml/pave/SitePages/Home.aspx) After the paving is complete and the roadway is returned to final lane configuration, a request to the Pavement Office is required so the final IRI smoothness can be determined. Final measurements require that traffic control or any detours be completely removed from the roadway and all paving is complete.

5-05 Cement Concrete Pavement

GEN 5-05.1 General Instructions

Concrete paving is a highly complex, mechanized operation and proper organization and planning of the work is essential on the part of both Contractors and WSDOT. Cement concrete pavement has a relatively high initial cost and WSDOT expects many years of satisfactory service from this type of pavement. It is imperative that the Project Engineer and Inspectors are thoroughly familiar with the specifications and techniques applying to the work, if this objective is to be attained.

Before construction begins, the Project Engineer should review all phases of the work, and see that all members of the crew are familiar with the duties to which they are to be assigned. Advance planning and organization of the engineering and inspection teams will do much to eliminate the confusion and improper construction sometimes found during the first day's work. All inspection equipment and testing tools should be on hand, and properly calibrated or certified, in advance of beginning of paving, and WSDOT materials testers properly qualified to perform the necessary concrete testing.

The Project Engineer should make certain that all Inspectors are instructed in the proper methods of keeping notes, records and diaries. Accurate records of construction progress and test results are absolutely essential in evaluating pavement performance through the years.

The Contract may contain the GSP, *Just in Time Training*. The purpose of this training is to bring all the parties to the table, and to raise understanding about the means and methods the contractor is proposing in order to comply with the Contract.

GEN 5-05.2 Testing Equipment/Reports

GEN 5-05.2A Testing Equipment

- Specified screens, sieves, and scales.
- Air meter.
- Straightedges and stringlines.
- Thermometers.
- Cylinder molds for casting concrete test specimens.
- Stop watch.
- Flashlights.

GEN 5-05.2B Records

The Project Engineer is responsible for the keeping of proper records that must include the following information:

- Record of cement received and used.
- Screen analysis of aggregates (see Chapter 9).
- Air-entraining agent used, and air meter test results.
- Rate of application of curing compound.
- Inspector's diaries.

GEN 5-05.3 Checklists

For the convenience of the Inspector, some of the most important inspection duties on concrete paving work are listed below:

GEN 5-05.3(1) Concrete Mix Design Approval

The Contractor's mix design should be reviewed by the Project Office to ensure that it meets the requirements of the Contract. The following items should be reviewed:

- Cementitious materials (Portland Cement, Low Alkali Cement, Blended Hydraulic Cement, Fly Ash, Ground Granulated Blast Furnace Slag, Microsilica Fume, and Metakaolin)
  - Verify products are listed on the QPL or have been approved through the RAM process.
  - Check that mill certification demonstrates specification compliance.
  - Verify the proposed quantities within specification limits for the concrete class.

- Aggregate (Coarse, Fine, and Combined Aggregate)
  - Ensure the aggregate is from an approved source by verification of the ASA database.
  - Check if ASR mitigation is required by verifying the ASA database.
  - Verify the mix design submittal includes data for Deleterious Substances.
  - Ensure the Nominal Maximum Aggregate Size (NMS) is correct for the proposed concrete class.
  - Verify the proposed gradation meet the requirements of the concrete class.
  - Make sure the mix design indicates the quantities of aggregate.
- Alkali Silica Reactivity (ASR)
  - If the aggregate source is ASR reactive, verify the Contractor provided mitigations measures.
  - Ensure the mitigation measures demonstrate compliance with *Standard Specifications* Section 9-03.1(1).
- Admixtures
  - Verify products are listed on the QPL or have been approved through the RAM process.
  - Ensure proposed quantities are within manufacturer's recommendations.
  - Verify all admixtures are from the same manufacturer.
- Water
  - Ensure the quantity of water is indicated on the mix design.
  - Verify the calculated water/cementitious materials ratio is equal to or less than 0.44.
  - If reclaimed water is proposed, verify it complies with *Standard Specifications* Section 9-25.1.
- Design Performance
  - Flexural Strength (650 psi or greater)
    - Verify that five 14-day flexural strength results are included with the mix design.
    - Ensure the flexural strength data indicates a quality level equal to or greater than 80% percent.
  - Compressive Strength
    - Verify that five sets of 28-day compressive strength results are included in the mix design.
    - Ensure the compressive strength data indicates an average compressive strength of 4000 psi or greater.
  - Air Content
    - Verify the mix design indicates air content between 3.0 -7.0 percent.

  To assist with the mix design review process the State Materials Laboratory has developed a mix design checklist that can be found at the Construction Office SharePoint site.

  The State Materials Laboratory is available to assist with the review of concrete mix designs.

GEN 5-05.3A Pre-Pave

1. Review Contract requirements (Plans, Standard Specifications, amendments to the Standard Specifications, and Special Provisions).
2. See that all testing tools and equipment are on hand and in good condition. Working with the Contractor, determine location(s) for the Contractor provided curing box(es) used for initially curing concrete test cylinders (*Standard Specifications* Section 5-05.3(4)A).
3. Check preparation of Subgrade; watch for soft spots. Check Subgrade elevations to ensure there are no high or low spots (*Standard Specifications* Section 5-05.3(6)). If HMA pavement placed on Subgrade prior to PCCP, refer to *Standard Specifications* Section 5-04 for HMA requirements.
4. Check that forms are in good condition and are set securely, true to line and grade (*Standard Specifications* Section 5-05.3(7)B). If a slip form paver is used, check position of wire, string line across the wire and check the depth to Subgrade or HMA pavement in at least three locations across the proposed paving area at each pin location.
5. Check that Subgrade or HMA is moist before the concrete is placed (*Standard Specifications* Section 5-05.3(6)).

GEN 5-05.3B Paving

6. Watch for variations in slump of mixed concrete batches (*Standard Specifications* Section 5-05.3(2)). In the case of slip-form paving, make frequent checks of the condition of the wire and edge slump (*Standard Specifications* Section 5-05.3(11)).
7. Make tests of air content, temperature, compressive test cylinders, and make complete, accurate records of test results and computations (*Standard Specifications* Section 5-05.3(4)A, 5-05.3(5)A, and Chapter 9). If maturity meters are used, document locations and periodically check output against maturity curve.
8. Check tie bars and dowel bars for rust and defects, that they are installed properly, secured to the grade, and located mid-depth of the slab if placed in baskets. Ensure that dowel bars receive a bond breaker if they are not precoated (*Standard Specifications* Section 5-05.3(10)). Be alert to anything in the paving operation that results in movement of the bars.
9. Watch for excessive movement of forms under weight of concrete paving equipment.
10. Check frequently to see that vibrators are operating properly (*Standard Specifications* Section 5-05.3(7)). If a dowel bar inserter is used, check spacing and alignment of dowel bars. Ensure that PCCP is consolidated after the bar is inserted and that slurry does not fill the insertion point.
11. Watch finishing operations to make sure excessive amount of water is not added to surface; allow fine spray only to be used (Section 5-5.3B).
12. Check the surface texturing operation to see that proper, uniformly textured surface is obtained (*Standard Specifications* Section 5-05.3(11)).

13. See that curing compound is placed uniformly, at the required rate, and at the proper time. The curing compound needs to completely coat the surface of the concrete (*Standard Specifications* Section 5-05.3(13)A). Note other curing methods are allowed in *Standard Specifications*.
14. See that concrete is consolidated properly at night headers (*Standard Specifications* Section 5-05.3(8)C).

GEN 5-05.3C Post Pave

15. Inspect joint sawing operation to see that required depth is cut, and that the best possible saw cuts are obtained (*Standard Specifications* Section 5-05.3(8)A).
16. Watch removal of forms; see that damage to pavement does not occur; require curing compound to be applied on edge of slab immediately following form removal (*Standard Specifications* Section 5-05.3(7)B).
17. See that additional curing compound is applied over areas scuffed by foot traffic.
18. Check that pavement is protected from traffic with necessary barricades, lights, etc. (*Standard Specifications* Section 5-05.3(16)).
19. Check that sawed contraction joints are sealed properly with joint sealant filler. Fill to between ¼ inch and ⅝ inch below the surface of the concrete and minimize any overflow (*Standard Specifications* Section 5-05.3(8)B).
20. Check pavement for early age cracking. Early age cracking is caused by volume changes as the concrete cures. These are usually hairline cracks and if they go unnoticed will lead to premature slab repair in the future.

SS 5-05.3 Construction Requirements

SS 5-05.3(1) Concrete Mix Design for Paving

The Contractor shall provide a concrete mix design for each design of concrete specified in the Contract. The proportions shall be determined in accordance with ACI 211.1. The same concrete Mix Design No. may be used in several of a concrete suppliers Plants. Note that a unique identification for the mix design is comprised of the combination of the Mix Design Number and the Plant Number.

SS 5-05.3(3) Equipment

A very important factor in obtaining a superior product with slip form paving is uniformity of operation. The Engineer should ensure that the plant, mixing facilities and hauling units are in quality and quantity balance to supply the paver with an adequate quantity of concrete for continuous operation at the recommended speed, without sacrificing uniform slump. Considerable pavement roughness can be attributed to spasmodic operation, and this should be held to a minimum.

SS 5-05.3(3)B Mixing Equipment

Nonagitating trucks are permitted to haul plant mixed concrete provided the concrete is delivered and discharged within 45 minutes after the introduction of mixing water to cement and aggregates, and the concrete is in a workable condition when placed Paver.

SS 5-05.3(3)C Finishing Equipment

The slip form paving equipment must be self-propelled and capable of placing, spreading, consolidating, screeding, and finishing the freshly placed concrete to the proper pavement elevation and cross-section within the specified tolerances. Sliding forms on the paver must be rigid to prevent spreading of the forms. The paving equipment must finish the surface in a manner which will minimize hand finishing.

Slip form pavers contain various combinations of all or some of the following components: auger spreader, spud vibrators, oscillating screeds, tamping bars, and pan floats. The equipment should be checked for calibration and satisfactory operation in accordance with the manufacturer's manual before paving is allowed to proceed.

If it is necessary to stop the forward movement of the paver, the vibratory and tamping elements should also be immediately stopped. No tractive force should be applied to the machine except that which is controlled from the machine.

SS 5-05.3(5) Mixing Concrete

It is very important that uniform consistency of the concrete be maintained with the water/cementitious ratio not exceeding 0.44 and the edge slump not exceeding ¼-inch. The *Standard Specifications* requirements for the water/cementitious ration is in Section 5-05.3(2) and the edge slump requirement is in Section 5-05.3(11). The current requirements for water/cementitious ratio and edge slump are intended to control consistency.

SS 5-05.3(6) Surface Preparation

Ahead of the paving operation, the Subgrade must be properly prepared with some type of "fixed" control template to accommodate the width of the paver. The Subgrade must be properly dampened so as to have no water demand from the mix, but, also, the concrete must not be placed on Subgrade on which pools of water have formed. If concrete is delivered by trucks on the grade, Subgrade disturbance should be kept at a minimum.

The Subgrade should be shaped and thoroughly compacted. Special attention should be directed to see that all parts of the Subgrade are firm and unyielding. Soft spots should be removed and backfilled with suitable material. *Standard Specifications* Section 5-05.3(6) requires that the Subgrade be prepared and compacted a minimum of 3 feet beyond each edge of the area to receive the concrete pavement in order to accommodate the width of the slip form paving equipment. The 3 foot extensions on each side of the Subgrade are tracklines that the slip form paving machines tracks will follow, and the smoothness of the tracklines directly affects the smoothness of the concrete pavement.

The Subgrade must be trimmed to the proper Subgrade elevation and shape. After trimming, the Subgrade shall be thoroughly wetted and compacted to achieve a dense unyielding surface. The Subgrade must be kept in this condition until the concrete is placed.

The elevation of the Subgrade should be checked either by stretching a stringline between the control wires and measuring down to the surface or by another method that provides for a satisfactory check. Extra checks should be made through crown and super transitions to be sure proper adjustments were made in the machine through this area and that no high spots exist.

Controls

If control stakes have not been set for previous operations, they need to be installed at this time. If the control stakes have previously been set, the installation of the wire shall be checked to verify that it is set to the proper line and grade. This is especially important if the wire is offset from its original position.

SS 5-05.3(7) Placing, Spreading, and Compacting Concrete

As paving progresses, the Inspector should be alert to the wire position just ahead of the machine, since the most precisely set control can be disturbed by workers or equipment hitting it. If you notice anyone or anything bumping, touching, leaning on or otherwise in contact with the control wire, notify the Contractor immediately. It is much easier to correct a misaligned control wire than repair the pavement after it has been placed.

The unconsolidated concrete in front of the paver should be kept well distributed by spreading or by dumping. As the truck or mixer discharges the mix onto the grade in front of the paver, the forces delivered to the machine should be held to a minimum, with all systems functioning as designed. If the paver is not moving, the vibration should be off. When vibration is in progress, it is important that the concrete becomes uniformly plastic for the full slab width as it passes through the vibration area. A lack of consolidation at one position on the machine could cause a potential fracture line parallel to the direction of movement and also a rough and uneven finished surface. The head of material in front of the paving machine should always be in accordance with the manufacturer's recommendation.

It is possible that experimentation may be necessary at the beginning of paving. To start, no trailing forms should be used on the machine and all finishing equipment should be engaged. This could then be modified if problems occur. One of the prime contributors to edge slump is high slump concrete. This should not be tolerated. Another is tie bar insertion for abutting lanes, which should be installed ahead of the final finishing.

Edge slump of the unsupported sides behind the paver is one of the major problems to be combated on slip form paving. The surface should be immediately straight edged by the Contractor and methods corrected to deliver a consistently true edge. Trailing forms can be used to give support beyond the length of the paver, but this may not be the answer. It is possible that more damage than good is done by trailing forms in some cases, by drag resistance pulling down the edge, or by mechanical vibration transmitted through the paver linkage to the form. This comment is also applicable to a trailing finisher. Remember that the concrete is between the moving forms only a few minutes and does not take its initial set until long after the forms leave it.

If water is added to the surface from a spray bar at the rear of the machine it should be in the form of a fine fog spray to avoid washing of the surface and extreme care must be exercised to see that the amount of water added is held to a bare minimum. Addition of excessive amounts of water during finishing will weaken the surface of the concrete and may result in hair checking or scaling of the pavement surface at an early date. If a considerable amount of water is continually required to finish the concrete, it may be better to add more water to the concrete mix to reduce the need for spraying water on the surface. Rain on a green unformed slab can cause disastrous edge slump and erosion. The Contractor should be encouraged to halt operations previous to this circumstance, and should be prepared to protect the pavement at all times.

Soon after the paving starts, and periodically thereafter, the slab template should be checked to insure that the "dry" template has not changed. This is done by stretching a line over the transverse wires and measuring down. This check should also be made through curves and transitions to ensure that the proper section adjustments are being made.

The slip form paver behaves similarly to an asphalt paver with the front probe approximately 3/16 inch higher than the rear. This will probably vary with the machine, due to mass distribution, etc.

Slope of less than this produces an unstable characteristic and an undulating profile, slopes in excess of the correct one cause the machine to repeatedly build up and then slump down. If the symptoms occur, this is one place to check. The machine also has about ¾ inch convergence in the sides, to encourage stability. Hand finishing, water adding, and other surface manipulation should be kept at a minimum.

SS 5-05.3(7)B Stationary Side Form Construction

Metal side forms or other forms accepted by the Project Engineer, conforming to the requirements of *Standard Specifications* Section 5-05.3(7)B, shall be used for the construction of cement concrete pavement when a slipform paving machine is not used unless the Contractor requests to use an accepted slip form machine.

It is essential that the base of the forms used have full, equal bearing upon the Subgrade throughout their length and width. The forms should be set true to alignment and grade and firmly staked with steel pins to avoid movement. The forms must never be set on blocks or pedestals. After the forms are firmly staked in place, a final inspection of line and grade should be made by sighting along the tops of the forms. Minor adjustments in grade can be accomplished by tamping additional Subgrade material under the form base by an accepted mechanical form tamper or by inserting small leveling wedges under the forms. It is important that the leveling wedges do not protrude into the cement concrete pavement so as to prevent uncontrolled cracking in the concrete pavement at the locations of the wedges. A small amount of concrete may seep under the forms and this concrete needs to be removed flush with the vertical face of the existing concrete pavement prior to placing new cement concrete pavement next to existing concrete pavement.

If major changes in alignment or grade are required, the forms should be removed and the Subgrade reshaped to the proper elevation and recompacted before resetting the forms.

SS 5-05.3(8) Joints

Isolation Joints – Drainage features and manholes placed within the concrete pavement are likely to cause a crack to develop in the concrete and need to be isolated from the rest of the concrete pavement by some type of premolded joint filler. Consult the contract plans and or *Standard Plans* for details. If no details are found contact the State Construction Office for guidance.

SS 5-05.3(8)A Contraction Joints

Longitudinal and transverse contraction joints shall be provided by saw cutting the surface in accordance with *Standard Specifications* Section 5-05.3(8) to the depth specified in *Standard Plan* A-40.10. The joints shall match transverse joints on adjacent concrete pavement and be at 15 foot intervals transversely on other areas.

As concrete cures and hardens, a change in volume occurs due to loss of moisture and cooling. This shrinkage results in tensile stresses being set up in the pavement, causing cracks to develop. History has shown that transverse cracks will develop at about 15 foot intervals along the length of a slab, and that a slab wider than 15 feet may crack longitudinally. The spacing for transverse contraction joints is a maximum of 15 feet; see *Standard Plans* A-40.10-00 for more information on spacing of transverse joints.

The purpose of contraction joints is to control the cracking of the concrete, thereby preventing ragged random cracks that spall and require expensive maintenance. Good construction of these joints is of the utmost importance, and inspection of this work is one of the most important phases of the Engineer's duties.

Contraction joints are weakened planes that collect the cracking into a controlled joint. These joints are made by sawing and pouring a hot or cold filler into the joint. The purpose is to create a maintainable joint in the slab and cause the crack to form along the plane of the joint.

This type of joint is constructed by sawing a groove in the hardened concrete to create a plane of weakness along which the crack will form. The saw cuts are made with the circular saw blades edged with diamonds. On full width construction, a gang sawing machine using several blades simultaneously is generally used to saw the transverse joints. When the gang sawing machine is used, the Inspector must see that the individual blades are properly aligned and set to cut the required depth.

It is necessary to control the time of sawing transverse joints very carefully, so that sawing may be done when concrete has hardened as much as possible without delaying so long as to allow development of random cracks. It is impossible to state a sawing schedule that will be ideal for every job, since curing conditions vary a great deal from job to job. Some generalizations can be made concerning sawing, but the Contractor on each job must determine from experience the most suitable schedule for that job.

It is desirable to delay sawing as long as possible to allow the concrete to gain enough strength to resist raveling adjacent to the saw cut. Sawing green concrete produces excessive wear on the saw blades, and causes washing, raveling, and other structural damages to the concrete near the joint. However, it may be necessary to make some early cuts to control cracking.

In general, a program of sawing control joints should be followed, sawing every fifth joint, not to exceed 64 feet, as soon as the concrete hardens sufficiently to resist excessive raveling. The beginning of sawing may vary depending on the type of base, concrete mix characteristics and weather. Sawing of the intermediate joints should follow the sawing of the control joints. It will usually be found possible to delay sawing the rest of the joints until the day following placement of the concrete (see *Standard Plan* A-40.10-00 for more information).

By observing the frequency of cracking and opening of joints the next day, it will be possible to lay out a sawing schedule that will give best results. If only the control joints are cracked, the sawing of the intermediate joints can be delayed further, given fairly constant weather conditions.

The Contractor should mark off the locations of the transverse joints and the inspector should check the spacing and frequently check to see that the specified depth of cut is sawed. The locations of the dowel bar baskets need to be marked on the grade prior to the dowel bar baskets being covered by the concrete pavement in order to correctly

locate the transverse joint saw cut in the middle of the dowel bars. Since much of the sawing will be done at night, the Inspector should be equipped with a good flashlight to properly examine the condition of saw cuts and to watch for random cracks.

When paving a lane adjacent to a previously paved slab, an early morning examination of joints in the existing lane will show the joints that are open and working. These locations should be marked for sawing control joints in the second lane. Friction at the construction joint and the tie bars will transmit stresses to the new slab and may cause random cracking to occur. For the same reason, uncontrolled cracks in the first lane should be matched with a control joint in the second. In addition, when cement concrete pavement is placed adjacent to existing cement concrete pavement, the vertical face of all existing working joints shall be covered with a bond breaker, such as polyethylene film, roofing paper or other material as accepted by the Engineer to prevent uncontrolled migration of the crack into the adjacent slab (*Standard Specifications* Section 5-05.3(8)A). If the Contractor proposes to use material other than polyethylene film or roofing paper as a bond breaker, the Project Engineer shall consult with the State Construction Office on the suitability of the proposed bond breaking material.

SS 5-05.3(8)B Sealing Sawed Contraction Joints

Prior to opening of the pavement to traffic, sawed joints must be sealed with an accepted type of filler material. Before application of the filler material, the joints must be thoroughly clean and dry. The sawed joints shall be free of dirt and dust. It is important that the saw cut be completely filled to within ¼ inch to ⅝ inch below the top of the concrete surface with the joint filler material. The Inspector can check this by probing the joint after sealing with a stiff wire and watching for sagging of the filler below the top of the joint.

SS 5-05.3(8)C Construction Joints

A construction joint shall be made at the end of each day's paving by placing a header board transversely across the pavement. Uncapped dowel bars should be installed in the joint, seeing that the dowels are parallel with the centerline and profile of the pavement. The ends of the dowels projecting from the header should be protected so that they will not be disturbed or moved from their correct positions.

Prior to beginning paving the following day, any broken curing seal on the end of the previous day's work must be re-sprayed with curing compound, and exposed dowel bars shall be coated with a parting compound, such as curing compound or grease to allow for future slab movement.

SS 5-05.3(9) Joint Matching Pre-Existing Pavement Joints

Prior to paving new PCCP in a driving lane, diamond grind a minimum of 3 feet of any preexisting pavement, that is scheduled to remain at the completion of the project, and is logitudinally adjacent to the new PCCP. This will produce a smooth surface to tie the new PCCP in to. The preexisting pavement shall be ground regardless if it is PCCP or bituminous.

SS 5-05.3(10) Tie Bars and Dowel Bars

Tie/dowel bars must be installed where specified in the *Standard Plans* M 21-01 (see *Standard Plan* Series A-40 and A-60). Tie bars must be placed so that equal lengths of the bars project into the two lanes of adjoining pavement. When paving two or more lanes at a time, the tie bars are placed at the juncture of the lanes by mechanical means. The Inspector must be alert to see that the bars are set at the proper spacing and depth and are properly centered between the two lanes.

When placing tie/dowel bars in the edge of a slab, the ends of the bars projecting from the forms should be protected against disturbance that might destroy the bond between the concrete and steel. The bars already in place shall be bent to lie close to the slab to permit preparation of the Subgrade of the adjoining lane, and carefully straightened to their proper position before placement of concrete.

SS 5-05.3(11) Finishing

After the concrete has been given the preliminary finish by the paving machine, minimal hand finishing may be required before the Contractor checks the surface with a straightedge device not less than 10 feet in length. High and low areas indicated by the straightedge shall be corrected. The requirements of checking the surface with the straightedge may be waived if it is demonstrated that other means will consistently produce a surface that meets the requirements for surface smoothness.

The final pavement texturing shall be either a tined finish or a finish produced by cement concrete pavement grinding.

For a tined finish, the pavement shall be given a final finish by texturing with a wire comb parallel to the center line of the pavement. The tining on small or irregular areas may be either parallel or perpendicular to centerline. It is important that the comb be used when the concrete is at the proper consistency. If the concrete is too soft, it will not retain the proper texture obtained by the comb, and if the concrete is too hard, the proper texture will not be achieved. The comb should be set up and ready to use well in advance of the time it will be required.

For a ground surface the pavement surface shall be ground to produce a uniform corduroy like texture in compliance with SS 5-01.3(9)A.

SS 5-05.3(12) Surface Smoothness

Smoothness is one of the most important pavement characteristics to road users. A smooth pavement provides a comfortable ride and reduces road noise. In addition to comfort, longer pavement life, reduced fuel consumption and less vehicle wear and tear are all attributes associated with smoother pavements. It is one of the factors that the public associates with the quality construction which reflects on the agency constructing it.

WSDOT uses the International Roughness Index (IRI) to evaluate pavement smoothness. IRI is a measure of smoothness in one wheel path only. Since both wheel paths affect pavement smoothness WSDOT averages the IRI in each wheel path to produce the Mean Roughness Index (MRI). When the term IRI is used within WSDOT, what is most often meant is MRI.

Driver comfort depends on how much of the pavement roughness is transmitted through a vehicle's suspension to the driver and occupants. MRI predicts driver comfort by using an algorithm to simulate the suspension movement felt by the driver of a virtual car. The higher the MRI the more the driver feels roughness in the pavement. When evaluating the MRI of a pavement it should be remembered that the goal of MRI testing is to improve driver comfort.

The Contractor is responsible for providing the inertial profiler and operator used for smoothness testing. To ensure the profiler is accurate and the measured profile is repeatable, the inertial profiler must have been certified within the last 12 months and the operator must have been certified within the last three years. Inertial profilers will either be certified by a certification facility or by another state. Profilers certified by a certification facility are required to display a decal or other approved marking as evidence of certification and the certification expiration date. If the inertial profiler is certified by another state, the Contractor is required to submit documentation verifying the profiler certification. Contact the State Pavement Office to verify that the certification meets the requirements of AASHTO R 56.

The specifications require MRI testing on all lanes of cement concrete pavement 0.25 miles in length or longer. Ramps, tapers and shoulders are exempt from IRI testing. All cement concrete pavement must meet 10-foot straightedge requirements regardless of whether it is subject to MRI testing of not.

The Contractor is responsible for collecting and analyzing the MRI data. The Contractor evaluates the profiles and submits the results to the Project Engineer for verification. Verification of the profile should include the following:

1. The filter setting used at the time of certification were used for the testing
2. The location of start, stop and excluded areas are correct
3. The MRI for each 52.8 foot (0.01 mile) segment has been measured (including excluded areas)
4. Incentive/disincentive is calculated correctly
5. Locations requiring corrective action are indentified.

The Contractors data should be verified using the Ride Quality Analysis tool in ProVal. The Project Engineer should request verification testing if there is reason to believe the Contractors testing is not accurate. Contact the State Pavement Office for assistance using ProVal or verification testing.

The Contractor is required to measure the smoothness of 52.8 foot segments that have an MRI greater than 125 inches per mile with a 10-foot straightedge. Locations that vary more than ⅛ inch from the lower edge of a 10-foot straightedge placed on the surface parallel to the centerline require corrective action. The goal of corrective action is to improve driver comfort by removing bumps that are causing the high MRI. If the Project Engineer determines that corrective action will not improve driver comfort the rough concrete pavement may be accepted with a credit as provided for in Section 5-05.5.

Travel lanes that are not subject to incentives and disincentives for MRI testing are still required to meet straightedge requirements. The Contractor is required to check them no later than 5:00 pm following the day of paving. If these areas do not meet the straightedge requirement, corrective action is required.

SS 5-05.3(13) Curing

Immediately following final finishing of the concrete or after free water leaves the surfaces, the curing compound should be applied. The purpose of curing, whatever method is used, is to prevent the loss of moisture required to hydrate the cement so that the concrete will gain its proper strength and durability. It is essential that a complete coverage of curing compound be applied to seal the exposed surface of the pavement.

On most paving work, specifications will call for machine application of the curing compound. It should be seen that the spray nozzle is adequately protected from the wind by shielding so that the compound is not blown off the pavement surface. The Inspector shall check to see that the specified rate of coverage is obtained.

The efficiency of the curing compound in preventing escape of moisture from the concrete is dependent upon the thickness of the membrane. For this reason, it is essential that the compound be evenly applied over the exposed surface at a rate of 1 gallon to not more than 150 square feet. Refer to *Standard Specifications* Section 5-05.3(13) for additional requirements for curing.

The curing membrane must be protected from damage by foot traffic or equipment. There is a certain amount of foot traffic required in sawing joints, operating the profiler and other operations. This traffic should be held to a minimum, and if damage from undue scuffing or other causes does occur, the area shall be re-sprayed with the required amount of curing compound. Care must be exercised so that curing compound is not sprayed into saw cuts, as the joint sealing compound will not adhere to the concrete in the joints if the curing compound is present.

When pavement is being constructed in early spring or late fall, the Project Engineer must be alert to predictions of freezing weather, and see that the Contractor is prepared to protect the fresh concrete from freezing, as required in *Standard Specifications* Section 5-05.3(14).

When special protection against freezing is required, the protective earth or straw covering must be placed against the sides of steel forms, if used, as well as on the surface of the pavement, since steel offers poor insulation to the change in temperature.

SS 5-05.3(17) Opening to Traffic

Standard Specifications Section 5-05.3(17) covers the requirements for opening cement concrete pavement to traffic. During the curing period designated for the concrete mix, the pavement must be properly barricaded to close it to all traffic. If necessary, the Contractor may be required to furnish a person to prevent traffic from using the pavement.

When the pavement has developed a compressive strength of 2500 psi, as determined from cylinders made at the time of placement, it may be opened to traffic. The pavement should be cleaned either by brooming or a pickup sweeper prior to opening.

SS 5-05.3(22) Repair of Defective Pavement Slabs

Broken slabs, slabs with random cracks, nonworking joints near cracks, edge slumping and spalls along joints and cracks must be replaced or repaired prior to completion of joint sealing. Areas of concrete pavement that are identified as needing replacement or repair need to be reviewed by the Project Engineer to determine if a repair or replacement of the concrete is most appropriate in accordance with *Standard Specifications* Section 5-05.3(22). There are times that small defects or spalls in the concrete should not be repaired as the repair is worse than leaving small defects or spall alone. The Project Engineer shall consult with the State Construction Office in making the determination on which areas should be repaired, replaced or leaving small spalls or defects alone.

SS 5-05.5 Payment

SS 5-05.5(1) Pavement Thickness

Standard Specifications Section 5-05.5(1) outlines procedures for thickness determinations and provides penalties when prescribed tolerances are exceeded. Before final payment, the pavement thickness will have to be determined in order to calculate the quantities.