CDOT Construction Manual

SECTION 400
PAVEMENTS

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SECTION 400
PAVEMENTS

400.1 GENERAL

Section 400 of the *Standard Specifications* governs the requirements for Portland cement concrete and hot-mix asphalt (HMA) pavement construction, including rehabilitative treatments. The following Sections briefly discuss considerations that are common to these pavement construction materials.

400.1.1 Quality Control/Quality Assurance Provisions

The Contractor is responsible for quality control, and CDOT is responsible for quality assurance, including final acceptance of pay items under the provisions of the Contract. It is the Project Engineer's responsibility to review the appropriate specifications and provisions for the project.

It is important that CDOT and Contractor personnel clearly understand their respective responsibilities. As such, these provisions are discussed at the Pre-paving Conference and at the beginning of each major phase of the project (see Appendix A for example Pre-paving Conference Agenda). The status and results of QC/QA sampling and testing are typically discussed during routine weekly meetings. Attendees generally include: Contractor Superintendent, Quality Control Supervisor, Paving Foreman, Plant Operator, Material Supplier, Trucking Foreman, Project Engineer, Project Inspectors, and QC/QA Testers.

400.1.2 Vertical Clearance Under Structures

The Construction Manager will verify the vertical clearance of structures before, during, and after construction on any new or rehab paving project that includes work under a structure. This requires measuring the vertical clearance under bridges and overhead

signs and reporting the findings to Staff Bridge Branch. See Appendix D for additional guidance.

SECTION 401
PLANT-MIX PAVEMENTS – GENERAL

Section 401 provides guidance and considerations that are common to inspecting typical CDOT plant-mix asphalt pavement projects.

401.1 PRELIMINARY CONSIDERATIONS

Before plant-mix production and paving operations begin, many factors should be considered. The following Sections briefly discuss these considerations.

401.1.1 Contract Plans and Specifications

Review the Contract, including any *Special Provisions*. Pay particular attention to the following:

1. type of pavement specified;
2. material specifications and mix design requirements;
3. temperature limitations (e.g., mix, mat, air);
4. number and thickness of courses;
5. construction dimensions and tolerances (e.g., widths, grades, cross-section);
6. compaction procedures and density requirements;
7. sampling and testing requirements and responsibilities; and
8. acceptance and payment criteria.

401.1.2 Asphalt Paving Publications

As needed for additional guidance, review and reference the following publications during the project:

1. *Hot-Mix Asphalt Paving Handbook*, American Association of State Highways and Transportation Officials (AASHTO);

2. *Segregation Causes and Cures for Hot-Mix Asphalt*, AASHTO;

3. *The Asphalt Handbook*, *Manual Series No. 4 (MS-4),* Asphalt Institute;

4. *Superpave Series No. 2 SP-2*, Asphalt Institute; and

5. *Special Report 180 Superpave Construction Guidelines,* National Asphalt Paving Association.

401.1.3 Job-Mix Formula

The Contractor is required to submit a proposed mix design. The Regional Materials Engineer's Office will review the proposed mix design and issue a Form 43 – Job-Mix Formula when the mix design has been approved. The Form 43 will include the following information:

1. mix design number;
2. mix gradation;
3. source of materials;
4. percent of materials;
5. name of suppliers;
6. percent of reclaimed asphalt pavement materials, if selected;
7. grade of asphalt binder;
8. warm mix asphalt technology, if selected; and
9. other relevant project information.

The Project Engineer should require the Contractor to have an approved Form 43 prior to the Pre-paving Conference. Verify that copies of the reviewed and accepted Form 43 are

distributed to the proper personnel. Changes affecting mix design (e.g., type and source of materials) require the Contractor to obtain a revised Form 43.

401.1.4 Longitudinal Joint and Pavement Marking Plan

The Contractor is responsible for submitting a Longitudinal Joint and Pavement Marking Plan that illustrates the location and configuration of longitudinal joints and pavement markings, including the proposed method of establishing control. Verify that the Contractor submits this Plan for review at least three days before the Pre-paving Conference. Acceptance must be provided in written form to the Contractor.

401.1.5 Pre-paving Conference/Communications/Quality Control Plan

Discuss project requirements with the Contractor at the Pre-paving Conference (see Section 400.1.1). Maintain effective communications with Contractor personnel (e.g., Superintendent, Foremen, Material Testing Supervisor, Certified Weigher). Feedback between the production plant and the paving site is invaluable to effect needed mix adjustments in a timely manner and ensure a quality pavement.

The Contractor is responsible for submitting a Quality Control Plan to the Project Engineer for review and acceptance before the paving operation begins.

401.1.6 Weather Conditions

Review the Contract limitations with respect to cold-weather paving and inclement weather, including allowable conditions for placing prime and tack coats and underlying pavement layers and surface lifts.

401.1.7 Foundation Preparation and Conditioning

Quality, in terms of surface smoothness and durability, will be no better than that of the underlying foundation (e.g., subgrade, base, existing pavement). If the foundation is not true to grade and cross-section or is rutted, the surface course thickness will vary, and it will be difficult to obtain uniform density. This will generally result in surface undulations, dips, and swales.

401.1.7.1 Subgrade/Base

Verify that the subgrade and/or base have been properly graded and compacted. Check the cross-slope, elevation, and alignment for conformance. Check for soft spots and ruts, and ensure that the Contractor corrects these deficiencies. Require that any damage to the subgrade or base be repaired before paving. Do not permit paving on frozen subgrade or base material. Approve the foundation preparation and conditioning work prior to placement of the surface course.

401.1.7.2 Existing Pavement

On rehabilitation projects requiring an overlay, any needed pavement repair shall be completed and approved before the overlay is placed. The entire surface, including edge of pavement, also must be swept and maintained in a clean and dry condition just prior to placing and compacting the plant-mix asphalt overlay.

401.1.8 Application of Prime and Tack Coats

As specified or directed, ensure that the underlying surface is properly tacked with an approved bituminous material before the mix is placed. In addition, verify that contact surfaces such as curbs, gutters, manholes, and barriers are tacked just ahead of the paving operation. Tack and prime coat materials should not be applied beyond the limits

of the final surface course. Where overspray or smearing is observed, require the affected surfaces to be cleaned. See Sections 407 and 411 for additional information.

401.1.9 Project Stationing

Verify that project stationing has been clearly marked for the purpose of documenting mix placement and yield checks. Review the method that will be used to perform yield checks. See the example for Form 282 in Appendix B for guidance on yield checks.

401.1.10 Compaction Test Section

The Contractor shall construct a test section using material that conforms to the approved Form 43 – Job-Mix Formula (see 401.1.3). The purpose of the test section is to establish the rolling pattern and sequence, including number, type, and combination of rollers, that are necessary to obtain target density. Density tests will be performed to verify compliance. The Contractor is responsible for documenting the results in a report to the Project Engineer. Before production paving begins, the Contractor shall have a Compaction Test Section Report that has been reviewed and approved by the Project Engineer. Changes to the compaction process will require a new compaction test section.

401.1.11 Mix Segregation

Mix segregation is the distribution of non-uniformly graded coarse and fine aggregate material throughout the mix. In simple terms, the aggregate material in various locations in the mat can fail to meet gradation specifications. This is a common problem with plant-mix asphalt pavements that should be closely monitored. Areas with too much coarse aggregate will be low in asphalt content and high in voids, which makes them prone to premature deterioration. Segregation can be introduced in several locations throughout the paving process (e.g., stockpiling, mixing, hauling, dumping, laydown). For example, segregation can be introduced where a windrow is not completely picked

up and deposited into the paver. *Suggested Best Practices for Minimizing Segregation* have been summarized in the HMA Pre-paving Conference Agenda.

401.2 PRODUCTION

401.2.1 Plant Facilities

The plant must be in good mechanical condition and have adequate capacity to balance production with the laydown and compaction operations. Prior to production, consider the guidelines in the following Sections.

401.2.1.1 Laboratory Facilities

Verify that the Contractor has furnished the required laboratory facilities and is prepared to perform the quality control sampling and testing specified in the Contract.

401.2.1.2 Air Quality Considerations

Verify that the Plant Operator is in receipt of a proper and current air quality certification from the governing State agency. See subsections 107.01 and 107.24 of the *Standard Specifications*.

401.2.1.3 Plant Scales

Verify scales with respect to certification, checks for accuracy and zero balance, and operation by a Certified Weigher (see subsection 109.01 of the *Standard Specifications*). Verify that the platform is clean, free of obstructions, and operating freely. Verify that scale tickets document the proper information.

Ticket takers shall verify correct information is provided on the scale ticket as required in subsection 109.01 and shall add:

1. Placement location (station or milepost)
2. Signature of ticket taker responsible for quantities and
3. Spread data.

401.2.1.4 Job-Mix Formula

Verify that the Plant Operator is in receipt of a properly completed and approved Form 43 – Job-Mix Formula.

401.2.2 Material Considerations

There are several factors related to material type, storage, and handling that should be considered at the plant, as discussed in the following Sections.

401.2.2.1 Component Materials

Prior to mix production, verify that component materials at the plant (e.g., aggregates, mineral filler, hydrated lime, bituminous material, reclaimed asphalt pavement, additives) have been properly sampled, tested, and approved for use as provided for in the Contract.

401.2.2.2 Aggregate Stockpiles

Aggregate stockpiles should be built in layers to minimize segregation and separated to avoid intermingling. Discourage any handling procedure that would push or dump aggregate over the side of a stockpile or otherwise degrade the material.

401.2.2.3 Aggregate Handling

To minimize segregation, the loader operator should work the full face of the aggregate stockpile. Dividers should be installed between cold-feed bin compartments so that aggregate piles do not overflow.

401.2.3 Mix Production and Storage

Once the plant is in operation, many factors should be monitored with respect to mix production and storage. Consider the guidelines in the following Sections.

401.2.3.1 Bituminous Materials

The bituminous material should be uniformly heated to the correct temperature. Localized overheating is unacceptable and should be carefully monitored. Improper handling can destroy or deteriorate the binder properties that are required by the Contract. Examples of improper handling include:

1. storing in tanks at excessive temperature,
2. storing for excessive periods of time,
3. mixing in the plant at excessive temperature, and
4. contamination by storing in tanks containing other material.

The mix discharge and delivery temperatures required in subsection 401.07 of the *Standard Specifications* should be verified. The Contractor should consult his binder supplier for further information on the ideal production temperatures appropriate for the grades of binder supplied to the project. In addition, verify the Contractor has a Field Binder Management Plan (see Colorado Procedure 11 in the CDOT Field Materials Manual, bullet 14).

401.2.3.2 Addition of Lime

Verify that lime is introduced to the aggregate as required. Verify the proportions of lime and water for conformance, and check that the pugmill uniformly combines the materials (see subsection 401.14 of the *Standard Specifications*).

401.2.3.3 Mixing Efficiency

Look for brown fines at the discharge conveyor. This is a good indication of non-uniform asphalt content caused by inefficient mixing, especially in drum-mix plants. The temperature of the dryer discharge gas, at the hood, should generally not be greater than 20 degrees higher than the aggregate temperature.

401.2.3.4 Mix Proportions

Verify that QC/QA samples and tests are performed as specified in subsection 106.05 of the *Standard Specifications* and the *Field Materials Manual*. Make frequent visual checks to ensure acceptability of the mix. If the aggregates are not completely and uniformly coated with bituminous material, it will result in non-uniform asphalt content. Check for signs of segregation.

401.2.3.5 Mix Discharge Temperature

Check the mix temperature at plant discharge for conformance with Contract requirements. Require adjustments as needed to conform.

401.2.3.6 Surge Silo Storage

Temporary storage in a surge silo is acceptable, provided it does not adversely affect mix quality (e.g., binder stripping, segregation, heat loss). Pay particular attention to

evidence of segregation. If the silo is improperly charged or operated, mix segregation is inevitable. The conveying device should deposit the mix into the center of the batcher at the top of the silo. The batcher gate should remain closed while charging, be fully opened when the batch is dropped, and then be quickly closed to prevent dribbling.

401.3 LOADING/HAULING OPERATION

The following Sections provide general inspection guidance.

401.3.1 Haul Trucks

The Contractor should have available an adequate number of haul trucks to provide a constant supply of mix to the paving site. Check that truck beds are tight, smooth, clean, and treated with an approved release agent before loading. Fuel oil is not an acceptable release agent.

401.3.2 Truck Loading Considerations

If trucks are not loaded properly, segregation of the mix may occur. Trucks should be laterally centered (i.e., left to right) under the discharge gate of the surge silo. Trucks should be loaded in multiple drops (e.g., first drop at the rear, second drop at the front, alternating drops in between). From three to seven drops may be necessary depending on the size of the truck (e.g., single unit, semi). The mix should not dribble from the bottom gate of the surge silo into the bed of the truck.

401.4 LAYDOWN OPERATION

Project Inspectors should focus on the following areas because poor workmanship often occurs at these locations: tapers, ramps, manholes, joints and where adverse paving conditions are encountered (e.g., cold weather, wind, rain, snow, equipment breakdowns).

401.4.1 Paving Equipment

Verify that approved and properly adjusted paving equipment is furnished and used by the Contractor. Pay particular attention to the acceptability of the receiving hopper, screed, strike-off assembly, automatic screed control, grade sensors, and sensor reference line. Verify the paver is capable of placing the mix uniformly and non-segregated in front of the screed. Check the length of the automatic leveling ski for acceptability.

401.4.2 Mix Delivery

Once an acceptable mix has been established, note the appearance of the load (e.g., peaking or flat, dull or shiny, white or blue smoke). A differing appearance in subsequent loads may indicate an unacceptable change in mix proportions or temperature. Visually inspect the mix for signs of segregation or incomplete coating of the aggregate. The Project Inspector should notify the Construction Manager if any of the previous conditions occur.

401.4.3 Charging the Paver Hopper

When mix is dumped into the paver hopper, the truck should be aligned properly with the hopper and should not bump or jar the paver. Before the tailgate is opened, the truck operator should first raise the bed to move the material to the tailgate. Once opened, this will provide the necessary surge of mix into the hopper, which minimizes segregation. If mix is spilled on the roadway in front of the paver, ensure that it is removed before the paver moves ahead. The hopper should be kept more than half full at all times.

401.4.4 Paver Operation and Adjustment

To ensure the mix is placed properly without segregation, consider the guidelines in the following Sections.

401.4.4.1 Paver Control

The paver should be operated under automated controls (e.g., screed controls, grade sensors, sensor reference lines). The proper use of this automated control system is paramount to ensure a quality pavement. However, the following instances of manual operation are acceptable:

1. Irregular Areas. Manual operation of the paver is permitted in irregularly shaped and minor areas (e.g., tapers). Closely monitor these areas for conformance.

2. Automated System Failure. If the automated control system of the paver fails, the equipment may be operated manually for the remainder of the workday. Paving shall not commence if the Contractor is unable to fix the control system before the next workday.

401.4.4.2 Paver Speed

The operator should use the slowest paver speed that will accommodate production and delivery of the mix. The paver should be stopped and started quickly at normal operating speed to avoid gradual deceleration and acceleration. This will minimize imperfections and damage to the mat such as holes, tears, and drags.

401.4.4.3 Material Feed

The feed sensor and flow gates at the rear of the hopper should be adjusted so that the quantity of material moved by the slat conveyor from the hopper to the midpoint of the augers is continuous. The hopper should be kept no less than half full.

401.4.4.4 Paver Hopper Wings

Paver wings should be cycled at a regular interval to prevent large buildups of the material. Material retained on the wings should not be incorporated into the pavement, unless regular cycling intervals are used. The material remaining after dumping the wings at the end of the day shall be disposed of properly and not incorporated into the pavement.

401.4.4.5 Augers

The augers should span the full-width of the screed. The auger height should be adjusted so that the bottom of the auger is at least two inches above the finished surface of the mat.

401.4.4.6 Screed

The paver should be equipped with a full-width vibratory screed. A sufficient quantity of mix should be supplied by the augers to maintain a constant level of mix in front of and across the full-width of the screed. The use of drag wings is unacceptable. Verify that the screed is in proper adjustment to produce an acceptable mat.

401.4.5 Quality Considerations

The Project Inspector should consider the following guidelines:

1. Surface and Texture. The surface of the mat should be uniform in appearance and texture (without holes, tears, gouges, drags, or segregation).

2. Segregation. If segregation is observed behind the paver, immediately notify the Construction Manager and the Contractor.

3. Mat Temperature. Check the temperature of the mat behind the paver screed for conformance. Ensure the mixture is at proper temperature before rolling. The risk of thermal segregation increases when paving in cool temperatures. See Section 401.5 for additional information.

4. Subsequent Lifts. Ensure that rejected areas (e.g., segregated areas, soft spots) have been corrected prior to placing a subsequent lift.

5. Cross-Section/Thickness/Yield. Ensure that the mat is placed in conformance with the required cross-section (e.g., slope, crown) and lift thickness. Check the total thickness and yield as required. Require screed adjustments, if necessary.

401.5 COMPACTION OPERATION

The mat will be uniformly compacted using the procedures established by the compaction test section (see Section 401.1.10). Consider the guidelines in the following Sections.

401.5.1 Rolling Procedures

Document the rolling procedures used by the Contractor. Particularly note deviations from the procedures established by the compaction test section (see Section 401.1.10) and any conversations with the Contractor.

401.5.1.1 Rolling Sequence

In general, the compaction operation will be sequenced as follows:

1. Initial Breakdown Rolling. Initial rolling is the first pass of the rollers on the freshly placed mat just behind the paver. It is used to break down and consolidate the mix.

2. Intermediate Rolling. Intermediate rolling is the second pass of the rollers that takes place just after initial rolling. It is performed to obtain the required mat density in accordance with applicable temperature requirements.

3. Finish Rolling. Finish rolling is performed after intermediate rolling to improve the finish of the surface. It is preformed while the mix is warm enough to permit the removal of roller marks.

401.5.1.2 Roller Speed

Rollers should, in general, not travel faster than approximately three miles per hour (brisk walking pace). A rippled surface may occur if the rollers are operated at too high a speed. The Contractor should avoid stopping rollers on the freshly placed mat.

401.5.1.3 Pneumatic-Tire Rollers

Where pneumatic-tire rollers are used, the compactive effort is directly related to the tire pressure. Verify that the correct tire pressure is used in accordance with the compaction test section.

401.5.1.4 Vibratory Rollers

Vibratory rollers can be used in either the static or vibratory mode. Where the vibratory mode is used, the frequency should be as high as practical without detriment to the mat. Consider the following guidelines:

1. Static Mode. Static mode, or non-vibratory rollers, should be used on mats that are less than 1.25 inches thick. The vibratory mode should not be used during finish rolling of surface courses or on waterproofed bridge decks.

2. Low Amplitude. A low-amplitude vibratory mode should be used for mat thicknesses between 1.25 and three inches.

3. High Amplitude. A high-amplitude vibratory mode should be used for mats greater than three inches thick.

401.5.1.5 Manual Compaction Methods

Hand-operated mechanical tampers should be used in areas that are inaccessible to rollers.

401.5.2 Temperature Considerations

Temperature plays a critical role in the compaction of plant-mix asphalt pavements and should be closely monitored. See subsection 401.07 of the *Standard Specifications.*

401.5.3 Joint Construction

The quality of longitudinal and transverse joints will affect the quality and long-term performance of the asphalt pavement. The surface must be smooth across the joints after

density is obtained. See Section 401.1.4 for additional information. The following Sections provide additional guidance.

401.5.3.1 Transverse Joints

When transverse joints are required, see subsection 401.18 of the *Standard Specifications*.

401.5.3.2 Longitudinal Joints

When longitudinal joints are required, see subsection 401.16 of the *Standard Specifications*. Refer to Colorado Procedure 11 in the CDOT Field Materials Manual, bullet 14.

401.6 SMOOTHNESS

Consider the following guidelines:

1. Contractor QC/QA Smoothness Profiling. The contractor shall perform the following QC operations for smoothness profiling:

    a. Profiler. The contractor will perform QC profiling on the first 2000 tons of the final layer. The profiler is operated by Contractor staff; this profiling does not have to be in the presence of a CDOT inspector. Only CDOT certified profiling equipment may be used for CDOT projects. A list of certified profilers can be found on the CDOT website at http://www.coloradodot.info/business/designsupport/design-docs . The contractor's staff must be properly trained and have a current LABCAT Level S certification. Retain a copy of the operator's certification.

Prior to QC profiling the contractor shall submit a traffic control plan for approval.

Profile results from the QC smoothness profiling must be submitted to the Engineer within 48 hours after profiling. The profile results shall show the Half-car Roughness Index (HRI) for each 0.1 mile section and areas of localized roughness. Paving should be suspended when profile results show corrective work is required. Paving will remain suspended until the contractor proposes corrective actions in writing to the Engineer

b. Straightedge. A 10-foot straight edge is supplied by the contractor. The straightedge method performed by the Contractor will be employed in areas not requiring profiling by the profiler or areas that could not be profiled by the profiler. Observe the operation, document deviations greater than 3/16 of an inch.

2. Initial Smoothness Acceptance Profiling. The Contractor's High Speed Profiler will be used for acceptance of the pavement. This profiling is performed prior to any corrective work to set the incentive and disincentive for each 0.1 mile section and to designate areas requiring corrective work. To prepare for the profiling the contractor shall perform the following:

a. Submit a traffic control plan that will allow the continuous collection of data for a lane. The traffic control plan shall allow the profiler to run the length of the lane at a constant speed without stopping.

b. The contractor shall mark the paving limits and each excluded area.

c. The contractor shall lay out a distance calibration site. This site may be outside the project limits, but must be checked by the inspector.

d. The lanes must be in their final configuration and allow the profiler to profile in the intended direction of traffic.

e. The lanes shall be free of debris and construction activity while profiling.

f. This profiling cannot occur when the pavement is wet or icy.

When the contractor is ready for acceptance, he must submit a written request at least 10 days prior to profiling.

After the profiling, the contractor shall submit the electronic data to the Project Engineer. The Project Engineer will submit the electronic data to the Staff Materials and Geotechnical Branch's Concrete Unit. The data needs to be submitted ASAP so that the contractor's profiling may be verified within the allowable amount of time. The Staff Materials and Geotechnical Branch's Concrete Unit may verify the Contractor's profile results and will notify the Project Engineer of its intent to verify the data. The contractor shall not perform any corrective work until after the verification profiling has occurred. The Project Engineer may call the Staff Materials and Geotechnical Branch's Concrete Unit prior to QA profiling to ask if the contractor needs to be verified. The verification profiling can take place at the same time as the contractor's QA profiling to save on traffic control.

A report for each lane will be sent to the Project Engineer showing the HRI for each 0.1 mile section, the incentive/disincentive for each 0.1 mile section and areas requiring corrective work. If the contractor performed any corrective work prior to this initial smoothness profiling, the engineer shall reduce the incentive for any 0.1 mile section where the contractor performed corrective work to $0.00 even if it was a short distance of grinding. The disincentive will not be changed.

3. Corrective Work. The contractor will perform the indicated corrective work and any additional corrective work to reduce disincentive payments. Once the corrective work is completed, recheck the acceptability of the corrected final surface with respect to texture and skid resistance. Joint sealant and pavement markings damaged by grinding shall be removed and replaced.

4. Final Smoothness Acceptance Profiling. The Contractor's Profiler will be used for acceptance of the pavement. This profiling is used to check that the contractor performed and fixed all areas of corrective work and to reduce the

disincentive payments. The profiling and contractor's responsibilities are the same as the initial smoothness profiling.

After the profiling, a report for each lane will be sent to the project showing the HRI for each 0.1 mile section, the revised incentive/disincentive for each 0.1 mile section and areas requiring corrective work. Each 0.1 mile section showing an initial disincentive can have that disincentive reduced or eliminated, but that section cannot earn incentive.

If corrective work is still indicated, the contractor shall perform the corrective work and the lane will be re-profiled. For every re-profile after the first Final Smoothness Acceptance Profiling, the contractor will be charged $500.

Verification profiling may occur on the final smoothness profiling instead of the initial profiling.

SECTION 403
HOT-MIX ASPHALT

403.1 GENERAL

The Contract Plans will designate the type and extent of base preparation, the number and thickness of mix courses required, and the lines, grade, and cross-section required for the final HMA surface. Use the guidelines presented in Section 401.

403.2 WARM MIX ASPHALT

Warm mix technology is an additive that the contractor may elect to use

Foaming is another warm mix technology where the asphalt producer injects water into the mix, through a special nozzle. Currently this technology is only approved for up to 10,000 tons per project, until performance data is submitted and analyzed. This method is less costly than the chemical additive used in the first warm mix asphalt method, as the only additive is water.

When either method of warm mix asphalt is used, it is treated the same as conventional hot mix asphalt, both in the field and in the laboratory, with respect to compaction and testing. The only difference is the contractor is able to obtain proper compaction at lower temperatures, thus being able to extend haul distances.

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SECTION 405
HEATING AND SCARIFYING TREATMENT

405.1 GENERAL

Heating and scarifying treatment is a rehabilitative process typically specified to recycle the uppermost layer of an existing asphalt pavement in preparation for a new asphalt overlay.

405.2 INSPECTION GUIDELINES

405.2.1 Before Construction

Before the heating and scarifying operation begins, consider the following guidelines:

1. Contract Plans and Specifications. Pay particular attention to the requirements for the rejuvenating agent.

2. Surface Preparation. Verify that the surface is properly prepared before the operation begins. The surface should be cleaned of all loose and foreign debris by using either mechanical or hand methods. Items such as manholes also should be clearly marked.

3. Equipment. Verify that the Contractor has available the proper type and number of equipment for the operation. Verify that the heating and scarifying, paving, and rolling equipment conforms to specified requirements. Pay particular attention to the acceptability of the type and number of steel-wheel and pneumatic-tire rollers provided.

4. Flammable Materials. Inform the State Patrol or local law enforcement agency of project scope and limits. Additional signing may be required.

405.2.2 During Construction

Consider the following guidelines during the heating and scarifying operation:

1. Width of Heating. Verify that the width of heating beyond that of scarification meets minimum specified requirements.

2. Width and Depth of Scarification. Check the width and depth of scarification for conformance. Verify that the Contractor maintains adequate control over the scarification depth and that testing is performed as required.

3. Overlap of Adjacent Passes. Adjacent passes of the heating and scarifying operation should overlap. Verify that the overlap of adjacent passes extends into the previously placed mat to the minimum specified requirements.

4. Temperature. Check the temperature of the scarified material for conformance. See subsection 405.03 of the *Standard Specifications.*

5. Rejuvenating Agent. Check the conformance of the rejuvenating agent applied to the scarified material. The agent must be applied while the scarified material is hot and before it is transferred to the paving machine.

6. Distribution of Material. After the hot recycled material is transferred to the paving machine, the mix will be distributed (i.e., screeded) to the cross-section designated on the Contract Plans. Verify the width, depth, and cross-slope for conformance.

7. Compaction. Immediately behind the paver, the rolling operation should begin. Check that the type and number of rollers and the rolling pattern employed meet the requirements for breakdown and finish rolling. Pay particular attention to the temperature of the material at the time of compaction, and verify that the required density is being obtained.

405.2.3 After Construction

Review the work to ensure acceptability, and discuss with the Contractor any unacceptable areas. Enforce the Contract provisions with respect to needed corrections. Do not allow the Contactor to place a subsequent asphalt overlay over the treated surface before the minimum specified elapsed time.

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SECTION 406
COLD ASPHALT PAVEMENT (RECYCLE)

406.1 GENERAL

Cold asphalt pavement recycling is typically specified as a rehabilitative treatment for asphalt pavements. The work generally consists of pulverizing (e.g., milling) the existing asphalt surface within the limits and to the depth required by the Contract, mixing a recycling agent with the pulverized material, and then spreading and compacting the recycled material to the specified grade, cross-section, and density.

406.2 INSPECTION GUIDELINES

406.2.1 Before Construction

Before the cold asphalt pavement recycling operation begins, consider the following guidelines:

1. Contract Plans and Specifications. Pay particular attention to the requirements for the pulverized material, recycling agent, temperature requirements, and sealing emulsion.

2. Surface Preparation. Items such as manholes should be clearly marked.

3. Recycling Equipment. Check the operation of the recycling equipment for conformance with respect to its pulverizing capabilities, control over width and longitudinal joint offset, automatic depth control, screening and crushing capabilities, continuous measurement of recycled material and automatic metering of recycling agent, and mixing and windrow placement capabilities.

4. Paving Equipment. Check the paving equipment for conformance. Verify the proper operation and adjustment of the pick-up machine, paver, and screed. The screed does not have to be heated.

5. Compaction Equipment. Check the compaction equipment for conformance. Both pneumatic-tire and steel-wheel rollers, either static or vibratory, will be required. The use of the vibratory mode for finishing requires previous approval.

6. Representative. Verify that a representative of the manufacturer of the recycling agent is present at the beginning of the operation and remains on site to provide guidance until acceptable production has been established.

406.2.2 During Construction

During the cold asphalt pavement recycling operation, consider the following guidelines:

1. Depth of Milling. Verify that the underlying material is not disturbed beyond the depth of milling designated on the Contract Plans.

2. Longitudinal Overlap. Verify that the overlap of adjacent passes meets specified minimum requirements.

3. End Overlap. Where the operation is halted, check that the operation is restarted by overlapping the end where the operation stopped.

4. Vertical Faces. Verify that the faces of vertical cuts in the pavement are properly cleaned during the operation and are not left overnight.

5. Mixing Operation. The recycling agent will be automatically metered based on the continuous weight measurement of pulverized material. Verify that the rate of application is calibrated to within allowable tolerance. Water may be added to the pulverized material to facilitate mixing uniformity.

6. Spreading Mix. Verify that the production of recycled material is balanced with paving for a continuous operation. Check that the mix is uniformly placed in windrows to prevent segregation. The paving equipment should pick up the entire windrow and place the recycled material in one pass to the required grade and cross-section.

7. Segregation Considerations. Watch for segregation in the windrows and the screeded surface, and enforce the provisions of the Contract with respect to removal and replacement of unacceptable mix. If segregation is evident, suspend the operation until the problem can be identified and corrected.

8. Compaction Operation. Pneumatic-tire rollers shall be used for initial breakdown and compaction rolling. Compaction should generally stop where no further displacement is observed. Hand methods will be necessary for areas inaccessible to rollers. Finish rolling will be performed with steel-wheel rollers using either the static or vibratory mode. Note, however, that the use of the vibratory mode requires previous approval and low amplitude. Verify that the required density is obtained and that the surface finish is free of roller marks and damage. Where cracks, movement, or pavement distress is observed, suspend the operation until the problem can be identified and resolved. Enforce the Contract provisions with respect to removal and replacement of deficient areas. See subsection 406.07 of the *Standard Specifications*.

9. Longitudinal Joints. Verify that longitudinal joints are laterally offset between layers at the specified minimum distance but do not fall in wheel paths.

10. Free Moisture Tests. Check that free moisture tests are being performed as required, and enforce the specified limits of free moisture before allowing placement of a designated sealing emulsion or asphalt overlay. Enforce the Contract provisions with respect to removal and replacement of damaged and soft areas before any sealing emulsion or asphalt overlay is placed. See subsection 406.07 of the *Standard Specifications*.

406.2.3 After Construction

Review the work to ensure acceptability, and discuss with the Contractor any unacceptable areas. Enforce the Contract provisions with respect to needed corrections and minimum time before opening the section to any traffic after compaction. A sealing emulsion may be specified to minimize surface raveling. Where applicable, verify the limits of treatment and rate of application for conformance. Where an asphalt overlay is designated, verify that the minimum overlay thickness is placed over the recycled pavement within the minimum specified time limit. Check the density, grade, and cross-section of the final surface for conformance.

SECTION 407
PRIME COAT, TACK COAT, AND REJUVENATING AGENT

407.1 GENERAL

Where prime or tack coat is specified, the Contractor will be responsible for preparing and treating the surface with a bituminous material within the limits designated on the Contract Plans. Prime coat is typically applied to a base or foundation course to provide a dust-free surface that promotes adhesion between the underlying surface and the overlying asphalt mix. The tack coat promotes bonding between the new and old materials. The rate of application should be carefully monitored. Too much tack coat promotes slippage between the two layers, rather than adhesion, and the excess material generally bleeds to the surface along construction joints. If tack coat is applied too far ahead of the paving operation, the material will usually collect a film of dust, which also causes poor adhesion.

407.2 INSPECTION GUIDELINES

407.2.1 Before Construction

Before prime or tack coat is applied, consider the following guidelines:

1. Contract Plans and Specifications. Pay particular attention to the type and grade of bituminous material specified and its application rate and temperature requirements.

2. Distribution Equipment. Verify that the distribution unit meets specified requirements with respect to material heating, circulation, and application control. Before the operation, verify that the application rate and the spray width have been properly set and that the distributor is capable of positively cutting off the flow of material.

3. Material Considerations. Retain and check the Certificates of Compliance and delivery tickets to ensure that the type and grade of bituminous material conform to specified requirements.

4. Surface Preparation. Verify that the surface to be treated has been properly prepared. The base must not be too dry, because this will cause the prime coat material to ball up. Before tack coat is applied, ensure that the existing surface has been properly repaired, patched, and swept. Vertical edges, such as curbs and manholes, must also be clean. Otherwise, the tack will not adhere to the surface.

407.2.2 During Construction

Consider the following guidelines during the application of prime and tack coats:

1. Application Rate. The application must be uniform and continuous at the specified rate. Verify that spray bar nozzles deliver without streaking. Skipped or deficient areas must be corrected. Excess material (e.g., overlaps, puddling) also must be corrected (e.g., squeegee, blotter material). In general, no more material than that needed for the day's operation should be applied. Overspray and smearing of curbs, gutters, and barriers is unacceptable and should be corrected. Consult the Project Engineer if penetration appears to be an issue.

2. Blotter Material. Where traffic must be maintained on the treated lane and the material does not adequately penetrate the surface, blotter material must be spread to absorb the excess bituminous material.

3. Traffic. Check for proper handling of traffic to prevent pickup, tracking, and contamination of the bituminous material. Traffic should generally be kept off the material as long as practical. Where traffic must be maintained on the facility, not more than one-half the width of the section should be treated in the same pass.

SECTION 408
JOINT AND CRACK SEALANT

408.1 GENERAL

Joint and crack sealing is a routine method of pavement rehabilitation. Joints and cracks in the pavement surface that are not properly sealed will allow water to infiltrate into the underlying layers of the pavement structure causing premature deterioration. Where joint and crack sealing is specified, the Contractor will be responsible for cleaning and preparing joints and cracks and furnishing and placing sealant material.

408.2 INSPECTION GUIDELINES

408.2.1 Before Construction

Consider the following guidelines before the joint and crack sealing operation begins:

1. Contract Plans and Specifications. Pay particular attention to the material requirements for the hot poured joint and crack sealant material.

2. Material. The Contractor shall supply approved sealant material and under no circumstance should different materials be mixed during the operation. The Materials and Geotechnical Branch pretests all batches of crack sealant. Contact the Bituminous Unit of the Asphalt Pavement Program (303) 398-6530 for approved crack sealant.

3. Equipment. Verify that the Contractor has adequate equipment to properly heat and pour the sealant material in a continuous operation.

4. Material Preparation. Check to ensure that the Contractor prepares the sealant material according to the manufacturer’s recommendations.

408.2.2 During Construction

During the joint and crack sealing operation, consider the following guidelines:

1. Crack Width. The Contractor should be sealing cracks between 0.125 and one inch in width.

2. Joint and Crack Preparation. Prior to sealing, verify that joints and cracks are properly cleaned of loose and foreign material to the specified depth. This operation is generally performed with hot compressed air. Immediately prior to sealing, the vertical faces of the joint or crack should be clean, dry, and warm. This promotes a positive bond of the sealant material to the vertical faces.

3. Sealant Temperature. Periodically verify the sealant temperature for conformance. Overheating degrades the material and should not be permitted.

4. Sealing Operation. Verify that the sealant is poured in the crack or joint reservoir to a height flush with the pavement surface. Excess sealant material must not remain on the surface but should be squeegeed to the specified width on either side of the crack or joint.

408.2.3 After Construction

Before opening to traffic, the sealant material should be allowed to cure sufficiently to prevent being picked up or pulled out of the crack or joint by traffic. If this becomes a problem, require blotter material to be applied to the sealant material. Enforce the Contract provisions with respect to removal and replacement of damaged seals.

SECTION 409
SEAL COAT

409.1 GENERAL

Seal coats are typically specified to lengthen the service life of an existing pavement and to improve the skid resistance of the surface. Prior to seal coating, it is important that the surface be properly prepared. The bituminous and aggregate cover materials must not be placed prior to the Project Engineer's approval of the prepared surface. The Contract Plans will designate the limits of treatment. Where the bituminous material is to be used as a fog seal, aggregate cover generally will not be specified.

409.2 INSPECTION GUIDELINES

409.2.1 Before Construction

Before the seal coat operation, consider the following guidelines:

1. Contract Plans and Specifications. Pay particular attention to the type, grade, and temperature requirements of the bituminous material, the gradation requirements of the aggregate cover material, and their respective rates of application.

2. Equipment. Check equipment for conformance. The Contractor should provide adequate bituminous distributors, aggregate spreaders, pneumatic-tire rollers, and rotary power brooms for a continuous operation. Pay particular attention to the distributor. It should have adequate means for controlling and monitoring the temperature, rate, and width of application of bituminous material.

3. Test Section. A test section will be used, as needed, to evaluate the application rates, yield, and penetration. Embedment of approximately 75 percent of

aggregate into the bituminous material is recommended. The operation should consistently use either butt or lap seams, but no seams should be placed in the wheel paths of operating traffic. The sequence of placement should minimize turning movements on the freshly placed surface.

4. Maintenance of Traffic. Verify that the correct types of temporary pavement markings and signing have been properly placed.

5. Surface Preparation. Prior to sealing, verify that the surface has been properly prepared and approved. The surface should be to the desired line and grade, free of irregularities, clean, and dry. Power brooms are generally used to remove loose and foreign material. Items such as manhole covers, drop inlets, valve boxes, and valley pans should be covered with dirt or paper to prevent bonding with the bituminous material.

409.2.2 During Construction

409.2.2.1 Application of Bituminous Material

During the application of the bituminous material, the Project Inspector should ensure conformance with respect to the type, grade, temperature, and application rate of the material within the limits designated on the Contract Plans. Consider the following guidelines:

1. Temperature/Initial Quantity. Check the temperature of the material in the distribution truck for conformance. Determine the initial quantity of material in the distribution truck before it is applied.

2. Distribution Bar/Nozzles. Check that the distribution bar applies at a uniform, continuous spread. End nozzles should be normal to the surface (i.e., turned at 90 degrees) to reduce overspray on curbs and reduce development of false seams. Adequate bituminous material should be applied along the seam line, not just oversprayed. The Contractor should have spare nozzles readily available.

3. Application Uniformity. Check to ensure that the bituminous material is applied at the specified rate uniformly over the surface in a continuous operation without producing deficient areas or areas of excess material. Check the yield as required for confirmation. Particularly watch for streaking. Halt the operation if streaking is observed and require corrective action. Junctions of adjacent passes should be closely monitored. Areas with too little or too much bituminous material must be corrected before application of the cover aggregate. In addition, the application rate should be adjusted to compensate for oxidized and open-graded surfaces. Contact the Project Engineer where such areas become problems.

4. Overspray. Check that the bituminous material is not oversprayed on adjacent items such as curbs and sidewalks. If observed, require the Contractor to thoroughly clean such excess.

5. End Overlaps. Pay particular attention to the start and cut-off operation of the distribution truck. The truck should be moving forward in the direction of application when the spray bar is opened or closed. Verify that building paper is used at the beginning and end of each spread. Such practice minimizes excess from overspray and dripping and helps to square the ends of application.

6. Length of Application. The length of application of the bituminous material should be balanced with the aggregate spreader. In general, the spreader should be maintained relatively close behind the distribution truck. Otherwise, the bituminous material may begin to cool sufficiently to prevent the aggregate from being embedded and held in place by the bituminous material when rolled.

7. Fog Seal. Where fog seal is specified, verify that the bituminous material is applied at the specified rate. Aggregate cover will generally not be required where fog seal is specified.

409.2.2.2 Application of Aggregate Cover

During the application of aggregate cover material, the Project Inspector should ensure conformance with respect to the type, gradation, and application rate of the material within the limits designated on the Contract Plans. Consider the following guidelines:

1. Material and Quantity. Check that the type and gradation of the aggregate material conforms to specified requirements. Record the quantity of aggregate delivered and spread (i.e., volume or weight from delivery ticket).

2. Dust Considerations. The cover material shall be moistened with water prior to placement to reduce dust emission. This also reduces the dust coating on the aggregate, which enhances bonding with the bituminous material.

3. Timing of Operation. The aggregate spreader should be following relatively closely behind the application of the bituminous material. Do not allow the aggregate to be placed on bituminous material that has been allowed to chill, set, or dry.

4. Width of Application. Check to ensure that the aggregate cover is placed within the limits of the bituminous material previously applied to the surface.

5. Application Rate/Yield. Ensure adequate coverage and verify the application rate and yield for conformance. Deficient areas must be adequately covered with additional aggregate, and excess piles must be trimmed prior to rolling.

6. Haul Truck Considerations. Verify that the equipment tires do not roll over and damage the freshly applied and uncovered bituminous material. Also check that equipment tires do not pick up the aggregate material. Enforce the Contract provisions with respect to needed repairs. To help embed the aggregate into the bituminous material, haul trucks should stagger their wheel paths.

409.2.2.3 Rolling Operation

After the aggregate has been spread, the rolling operation should begin immediately behind the spreader to embed the aggregate into the bituminous material. Consider the following guidelines:

1. Roller Tires. The correct pressure should be used in the tires of the pneumatic-tire rollers. Pay particular attention to the operation to ensure that the aggregate is not picked up by the tires.

2. Rolling Operation. To properly embed the aggregate, pneumatic-tire rollers should perform three complete passes over the aggregate prior to the bituminous material taking its initial set. Verify that the rolling operation is keeping up with the aggregate spreader; otherwise, it will be difficult to embed the aggregate into the bituminous material. Verify that areas of exposed bituminous or loose aggregate are not left at the end of the day. In addition, rapid start and stop movements should be avoided to minimize damage to the treated surface.

3. Coverage. Check the surface behind the rolling operation to ensure that adequate coverage of aggregate remains over the bituminous material. Require correction of areas identified with deficient or excess aggregate material.

4. Embedment. Check the acceptability of embedment of the aggregate in the bituminous material. Embedment of approximately 75 percent of aggregate into the bituminous material is recommended. In addition, check for proper bonding of the two materials. If weak bonding is evident after the bituminous material takes its initial set, notify the Contractor of the deficient area.

5. Bleeding. Blotting sand should be used in areas where excess bituminous material bleeding occurs.

409.2.2.4 Brooming Operation

After the rolling operation has embedded the aggregate into the bituminous material and set sufficiently to hold bond, the brooming operation should begin. Brooming is performed to remove loose aggregate and chips that did not bond with the bituminous material. The operation is generally performed at the beginning of the next work day. Ensure that the operation does not remove embedded aggregate. In such cases, lighter brooming or a delay in the operation may be needed.

409.2.3 After Construction

After the brooming operation, verify the acceptability of the final surface with respect to proper coverage, embedment, and bonding of the aggregate with the bituminous material. Enforce the Contract provisions for any needed surface corrections. Verify the correct installation of traffic control devices (e.g., temporary paving markings, drums) prior to opening the section to traffic.

SECTION 411
ASPHALT MATERIALS

411.1 GENERAL

Various types of bituminous materials may be specified in the Contract, and the type specified will depend on its intended application (e.g., prime, tack, seal coat).

411.2 INSPECTION GUIDELINES

411.2.1 Before Construction

Before the Contractor applies the bituminous material, consider the following:

1. Contract Plans and Specifications. Pay particular attention to the type and grade of bituminous material specified and any dilution or additive requirements.

2. Storage. Depending on the project, several different types of bituminous material may be necessary for different operations. Check to ensure that the Contractor properly stores different types of bituminous material separately without mixing. Verify the Contractor has a Field Binder Management Plan (see Colorado Procedure 11 in the CDOT Field Materials Manual).

411.2.2 During Construction

Check to ensure that the Contractor's application operation does not result in overspray on adjacent items such as curbs, gutters, sidewalks, and structures. Enforce the Contract provisions with respect to cleaning such marred areas.

411.2.3 After Construction

In general, it is best not to close the facility to traffic, even if this means maintaining a one-way operation. In such cases, verify that the bituminous material is not over-sprayed into the adjacent lane. To avoid damage from traffic, do not open the facility to traffic until the bituminous treatment has sufficiently cured.

SECTION 412
PORTLAND CEMENT CONCRETE PAVEMENT

412.1 PRELIMINARY CONSIDERATIONS

The construction of Portland cement concrete pavement is a highly mechanized operation that requires the inspection of a vast quantity of material and a working knowledge of numerous types of equipment. Project Inspectors that are assigned to the work should be thoroughly familiar with the Contract Plans and Specifications, *Special Provisions*, construction methods and details, and the sequence of operations.

412.1.1 Contract Plans and Specifications

Pay particular attention to the class of concrete required, component material specifications, mix design requirements, consistency requirements for the proposed method of operation, and the requirements for reinforcement, dowel bars, tie bars, joint sealant, and curing materials. Become familiar with the proposed method and sequence of operation with respect to mix production, mix hauling, joint construction, reinforcement and concrete placement (i.e., fixed form, slip form), finishing, curing, joint sawing, profiling, surface tolerance, and slab and surface correction requirements.

412.1.2 Portland Cement Concrete Mix Design

Before mix production and paving begins, the Project Engineer and Project Inspector should understand the mixing and batching procedures, and be able to verify that the Portland cement concrete mix design has been approved for use on the project.

412.1.3 Process Control Plan

Verify that the Contractor's Process Control Plan has been submitted and approved. The Process Control Plan will document the Contractor's proposed sampling and testing procedures for quality control of pavement thickness. It shall address the sampling and testing method and frequency for traffic lanes, shoulders, intersections, entrances, and crossovers. Use the Process Control Plan to verify conformance of quality control by the Contractor.

412.1.4 Pre-paving Conference/Communications

Discuss project requirements and sequence of operations with the Contractor at the Pre-paving Conference (see Section 400.1.1). Establish and maintain communications with Contractor personnel (e.g., Superintendent, Foremen, Material Testing Supervisor, Certified Weigher). During the paving operation, communication between the plant and the paving site is invaluable to effect needed adjustments to the mix and ensure quality.

412.1.5 Equipment Considerations

Verify the acceptability of the number and type of equipment supplied by the Contractor. Consider the following:

1. Hauling/Placing Equipment. Check the acceptability of haul trucks, spreading, strike-off, consolidation, and finishing equipment for the particular method of paving used (i.e., fixed-form or slip-form paving).

2. Load Transfer Devices/Bars. Check the location and operation of equipment used to place load transfer devices and bars.

3. Vibrators. Check vibrators for conformance with respect to specified type, diameter and spacing. Frequency of vibrators should be tested and documented.

4. Test Bridge. Verify the acceptability of the test bridge provided for CDOT personnel.

5. Joint Sawing Equipment. Check that extra saws, blades, and lighting equipment have been provided to continue joint sawing sufficiently to control cracking.

6. Curing Equipment. Verify that standby equipment has been provided for the curing operation in the event of a mechanical breakdown.

7. Texturing Equipment. Check the acceptability of the equipment needed for surface texturing.

8. Concrete Protection. Check that the Contractor has available the tools and materials necessary to protect the concrete from cold and wet weather damage.

9. Profiler. Check that the high speed profiler has been calibrated as specified.

412.1.6 Utilities

Verify that the manholes, inlets, and utilities that will be incorporated into the pavement are properly located and marked.

412.1.7 Subgrade/Base Preparation

Check that the subgrade/base has been constructed to the required grade and cross-section and compacted to the required density. Ensure that high or low spots and soft or muddy spots have been properly corrected. The final grade must be in a smooth and non-frozen condition. Where the prepared grade is untreated, verify that the material is maintained in a moist condition just ahead of the paver without forming mud or pools of water. Intermittent sprinkling may be required.

412.1.7.1 Fixed-form Considerations

For fixed-form paving operations, consider the following guidelines:

1. Rail Forms. Verify rail forms for conformance with respect to dimensions and condition. Rails should be clean and in good repair. Reject damaged forms.

2. Limits of Trimming. Check the limits of trimming beyond the width of the forms. This area will be used as a track path for finishing, curing, and surface texturing equipment.

3. Foundation. Verify that the rail foundation is uniform and properly compacted. The foundation must support the operation so that the top face of the rails remains flush with the final pavement surface without moving.

4. Rail Movement. Verify rails are secured with stakes and locked pins. Check for movement in any direction. Visible springing or settlement is unacceptable.

5. Oiling. Ensure that the forms are thoroughly cleaned and coated with oil or other approved release agents.

6. Resetting/Removal. Require resetting of unacceptable forms. The forms should not be removed until the concrete has set sufficiently to hold the edge of the slab.

412.1.7.2 Slip-form Considerations

For slip-form paving operations, the Contractor shall adjust the automatic alignment and elevation controls to spread, consolidate, screed, and finish the concrete in a single pass.

412.2 REINFORCEMENT AND JOINT CONSIDERATIONS

There are many factors that the Project Inspector should consider with respect to the provisions for reinforcement and joint construction. Consider the guidelines in the following Sections.

412.2.1 Reinforcing Steel

Where reinforcing steel is specified, check the reinforcement for conformance with respect to material type and condition. Verify that the Contractor properly stores the reinforcing steel without damage or degradation. Pay particular attention to the storage and handling of epoxy coated bars. Require repair or replacement of the epoxy coated material, as needed. Verify the acceptability of the placement operation. Check the method of securing bars and the depth and location of placement. Observe the consolidation operation for evidence of unacceptable bar movement. Vibrators must not come into contact with reinforcement.

412.2.2 Construction Joints

Use the following guidelines to inspect longitudinal and transverse construction joints:

1. Longitudinal Construction Joints. Where longitudinal construction joints are built, check the following for conformance:

    a. Location. Check that longitudinal construction joints are properly located, especially with respect to lane lines.

    b. Keyways. Verify the correct installation of keyways. It is preferable to construct female keyways.

    c. Tie Bars. Where tie bars are specified, verify the diameter and length of the epoxy coated bars for conformance. Observe the insertion operation

for proper location and spacing of bars. Ensure that the Contractor demonstrates, by testing, the required pullout resistance where tie bars are stabbed or drilled and epoxied into place.

2. Transverse Construction Joints. Verify that transverse construction joints are properly located and constructed. Check to ensure the location of joints for conformance with minimum spacing requirements.

412.2.3 Weakened Plane Joints

Use the following guidelines to inspect longitudinal and transverse weakened plane joints:

1. Longitudinal Weakened Plane Joints. Where longitudinal weakened plane joints are constructed, check the following for conformance:

    a. Location. Check that longitudinal weakened plane joints are properly located, especially with respect to lane lines.

    b. Tie Bars. Where tie bars are specified, verify the diameter and length of the epoxy coated bars. Check that the bars are inserted by an approved method ahead of the vibration operation. Observe the insertion operation for proper location, depth, and spacing of bars.

    c. Sawing. Check the dimensions of saw cuts. Ensure that the sawing is completed at the proper time to prevent random cracking and raveling.

2. Transverse Weakened Plane Joints. Where transverse weakened plane joints are constructed, check the following for conformance:

    a. Location. Check that transverse weakened plane joints are located as designated on the Contract Plans.

b. Load Transfer Devices. Verify that dowels conform to the specified type, diameter, and length of material. Check to ensure that the number and size of shipping braces does not exceed what is specified in subsection 412.13(b)2 of the *Standard Specifications*. Check to ensure that the horizontal support wires and shipping braces are not cut prior to concrete placement and that the assembly is firmly secured to the subbase as required. Check welding to ensure that only one end is welded. Check the tolerance of placement for acceptability with respect to location, depth, and spacing. Ensure that the Contractor marks the center of the dowel assembly on both sides of the slab for reference by the saw crew. Verify dowel lubrication for conformance. Ensure that joints in widening and shoulders align with those in the adjacent slab.

   The Project Inspector should do quality assurance to ensure the location of the dowels in the plastic pavement behind the paver.

c. Sawing. Check the dimensions of the saw cuts for conformance. Ensure that the sawing is completed at the proper time to prevent random cracking and raveling. If uncontrolled cracking is observed, verify that the Contractor moves the sawing operation ahead and then returns to saw the joints that were skipped.

412.2.4 Expansion Joints

Check that transverse expansion joints are properly constructed at the locations specified. Verify that preformed joint filler material is placed at all structures, manholes, inlets, and other projections into the pavement.

412.3 PLACEMENT AND CONSOLIDATION OPERATION

412.3.1 Moistening of Grade

Just ahead of the placement operation, verify that the grade is kept moist without creating standing water or soft spots. Additional sprinkling of the grade may be required throughout the day, especially during hot, dry, and windy conditions.

412.3.2 Hauling and Delivery Considerations

For each load, retain the delivery ticket and check that the required information is provided. Refer to subsection 601.06 of the *Standard Specifications* for details on delivery tickets requirements. Check the mix for acceptability. The mix should be visually similar from load to load with respect to uniformity and consistency (i.e., slump). Pay particular attention to signs of segregation, and verify that the mix temperature is within acceptable limits. Ensure that molds for strength tests are cast as required and that air and slump tests are performed as specified. Verify that the concrete is completely discharged within the required time limits, especially from non-agitating trucks. When water is added to truck mixers, record the additional quantity, verify the water-cement ratio and record the number of mixer revolutions before discharge. Pay particular attention to any unacceptable movement of joint and reinforcement materials when the concrete is deposited.

412.3.3 Spreading and Strike-Off Considerations

Concrete shall be deposited uniformly over the base ahead of the strike-off operation. Concrete should be placed so that minimal rehandling is necessary. Where hand methods are needed, verify that shovels, not rakes, are used. Workers with muddy boots should not be permitted to walk through the freshly placed concrete. Ensure that any footprint areas are properly vibrated.

412.3.4 Vibration Considerations

The concrete should be vibrated across the full width of the slab. Observe consolidation and require any needed frequency adjustments. When the equipment train halts, verify that vibrators are shut off. If any vibrator malfunctions, halt the operation until it can be effectively repaired or replaced. Verify that hand-held vibrators are used to consolidate concrete adjacent to forms and joint assemblies.

412.4 SURFACE FINISHING OPERATION

412.4.1 Floating Considerations

After the concrete has been placed, struck off, and consolidated, the floating operation will begin. Hand floating is only permitted to finish areas inaccessible to finishing equipment (e.g., narrow widths, irregular shapes) and for short periods where finishing equipment breaks down. The Contractor should not use the CDOT test bridge for the finishing operation. Verify the grade and cross-section of the floated surface for conformance. Check for surface irregularities and enforce the Contract provisions with respect to stopping work and correcting surface defects. Check the edge for rock pockets and edge slump. A consistent concrete slump will promote a consistent slab edge.

412.4.2 Adding Water to Surface

The Contractor shall not be permitted to add water or finishing aids (water with a small amount of chemical) to the surface for the purpose of finishing the concrete. The intent is to ensure that the concrete placed will be high quality and durable In situations where the surface becomes dry and difficult to finish, as evidenced by tearing, paving shall cease and adjustments be made to the concrete mix or paving sequence.

412.4.3 Surface Texturing

Verify that the surface is textured in an acceptable manner. The acceptability of the surface texture is determined by CP 77 Method B. If the texture is deficient, identify the limits of the deficiency. Deficient surface texture will be corrected by diamond grinding prior to pavement smoothness testing. Consider the following guidelines:

1. Plastic Turf/Burlap. Where plastic turf and burlap are used, verify that the dragging operation completely covers the surface and produces a uniform gritty texture. The drag material should be maintained clean and free of dry mortar. Require replacement of the material as needed to ensure production of an acceptable texture. Burlap should be maintained in a moist condition during the operation; however, the quantity of added water shall not be enough to introduce additional water to the surface of the concrete.

2. Diamond Grinding. Diamond Grinding shall be uniform in appearance. Diamond grinding shall not occur prior to the concrete achieving a compressive strength of at least 2500 psi.

412.4.4 Stationing

Verify that stations are imprinted on the pavement surface at the specified locations.

412.4.5 Rumble Strips

Verify that rumble strips are placed where specified (e.g., deceleration lanes, ramps, shoulders). Check the size, shape, depth, and orientation of the strips for conformance.

412.5 CONCRETE CURING OPERATION

Immediately after finishing, check that the surface and edges are completely and uniformly sprayed with an approved impervious membrane material. Concrete shall not be exposed for more than 10 minutes before being covered with curing compound. Verify the rate of application for conformance. Edges and irregular areas will usually be sprayed by hand. Halt paving if operations are not balanced sufficiently to ensure timely and adequate treatment. Ensure that all membrane damaged within 72 hours of application is immediately repaired. The Contactor shall be adequately prepared to protect the pavement from rain and cold weather damage. Use strength tests to verify compressive strength before allowing equipment to operate on the new slab.

412.6 SLAB REPAIR WORK

Know the conditions requiring repair work and the limits of removal and replacement. Coring should be used as needed to verify questionable areas. Enforce the Contract provisions with respect to repairing deficient areas. Verify that spalled joints and cracks are corrected as specified.

412.7 SURFACE SMOOTHNESS TESTING

After the concrete has cured sufficiently to support the smoothness testing operation, test the pavement (i.e., mainline, shoulders, ramps) according to the method specified. Consider the following guidelines:

1. Contractor QC Smoothness Testing. The contractor shall perform the following QC operations for smoothness testing:

    a. Profiler. After the concrete has cured sufficiently to support the smoothness testing operation, 1,000 psi for a light weight profiler (LWP) or 2,000 psi for a high speed profiler (HSP), the contractor with perform QC testing of each day’s paving, high speed or light weight. The profiler is

operated by Contractor staff; this testing does not have to be in the presence of a CDOT inspector. The profiler shall be certified according to CP78 to test concrete pavement. A list of certified profilers can be found on the CDOT website at http://www.coloradodot.info/business/designsupport/design-docs . The contractor's staff must be properly trained and have a current LABCAT Level S certification. Retain a copy of the operator's certification.

Prior to QC testing the contractor shall submit a traffic control plan for approval.

Test results from the QC smoothness testing must be submitted to the Engineer within 48 hours after testing. The test results shall show the Half-car Roughness Index (HRI) for each 0.1 mile section and areas of localized roughness. Paving should be suspended when test results show corrective work is required. Paving will remain suspended until the contractor proposes corrective actions in writing to the Engineer

b. Straightedge. A 10-foot straight edge is supplied by the contractor. The straightedge method performed by the Contractor will be employed in areas not requiring testing by the profiler or areas that could not be tested by the profiler. Observe the operation, document deviations greater than 3/16 of an inch.

2. Department Initial Smoothness Acceptance Testing. The Department's High Speed Profiler will be used for acceptance of the concrete pavement. This testing is performed prior to any corrective work to set the incentive & disincentive for each 0.1 mile section and to designate areas requiring corrective work. To prepare for the Department's testing the contractor shall perform the following:

a. Submit a traffic control plan that will allow the continuous collection of data for a lane. The traffic control plan shall allow the department's profiler to run the length of the lane without stopping

b. The contractor shall mark the paving limits and each excluded area.

c. The contractor shall lay out a distance calibration site. This site may be outside the project limits, but must be checked by the inspector.

d. The lanes must be in their final configuration and allow the profiler to test in the intended direction of traffic.

e. The lanes shall be free of debris and construction activity while testing.

f. This testing cannot occur when the pavement is wet or icy.

When the contractor is ready for acceptance, they must submit a written request at least 10 days before they want the testing to occur. Since the Department only has one profiler, the contractor's requested date may not be available and will need to be rescheduled. The project will schedule the department's profiler by calling the Staff Materials and Geotechnical Branch's Concrete Unit at 303-398-6548 or 303-398-6549.

After the testing, a report for each lane will be sent to the project showing the HRI for each0.1 mile section, the incentive/disincentive for each 0.1 mile section and areas requiring corrective work. If the contractor performed any corrective work prior to this initial smoothness testing, the engineer shall reduce the incentive for any 0.1 mile section where the contractor performed corrective work to $0.00 even if it was a short distance of grinding. The disincentive will not be changed.

3. Corrective Work. The contractor will perform the indicated corrective work and any additional corrective work to reduce disincentive payments. Once the corrective work is completed, recheck the acceptability of the corrected final surface with respect to texture and skid resistance. Joint sealant and pavement markings damaged by grinding shall be removed and replaced.

4. Department Final Smoothness Acceptance Testing. The Department's High Speed Profiler will be used for acceptance of the concrete pavement. This testing is used to check that the contractor performed and fixed all areas of

corrective work and to reduce the disincentive payments. The testing and contractor's responsibilities are the same as the initial smoothness testing.

After the testing, a report for each lane will be sent to the project showing the HRI for each 0.1 mile section, the revised incentive/disincentive for each 0.1 mile section and areas requiring corrective work. Each 0.1 mile sections showing an initial disincentive can have that disincentive reduced or eliminated, but that section cannot earn incentive.

If corrective work is still indicated, the contractor shall perform the corrective work and the lane will be retested by the Department. For every retest after the first Final Smoothness Acceptance Testing, the contractor will be charged $500.

412.8 JOINT SAWING AND SEALING

412.8.1 Sawing Operation

Verify that the location of cuts that are sawed over load transfer devices are within specified tolerance. On the same day joints are to be sealed, verify that the saw cuts are properly cleaned and that all residue is removed from the joint reservoir and surface (e.g., flushing with water, sandblasting, compressed air). Follow the requirements of subsection 107.25 of the *Standard Specifications* for concrete slurry removal.

412.8.2 Sealing Operation

The sealing operation will begin after completion of all corrective work, joint sawing, and curing. Immediately prior to placement of the backer rod and sealant material, verify that the joint reservoir is further cleaned with compressed air. Pay particular attention to any oil or moisture that may be blown into the cavity. This will prevent the sealant from bonding with the walls of the reservoir. Require additional cleaning as needed. The sealing operation should not be conducted during wet weather conditions or when the

ambient temperature falls below the manufacturer's recommendations. Verify that the sealant material is properly stored, prepared, and heated prior to application. Check the acceptability of the installed backer rod and sealant material (e.g., depth, height in relation to slab surface). Require the Contractor to clean any sealant material that may have smeared on the pavement surface.

412.9 PAVEMENT THICKNESS DETERMINATION

Ensure that the Contractor's coring operation conforms with the requirements of the Contract Specifications and the Contractor's Process Control Plan (see Section 412.1.3). Pay particular attention to the frequency of coring required for the mainline, shoulders, intersections, and miscellaneous areas. Verify that the Contractor documents daily thickness measurements. Acceptance tests must be witnessed by the Project Inspector and will be based on the length of core samples measured at the time the cores are taken by the Contractor. Determine the average length of cores and require additional coring as specified for deficient areas. Enforce the provisions of the Contract with respect to any needed price adjustments and the removal and replacement of unacceptable slabs. Verify that the Contractor properly fills all core holes left in the pavement.

412.10 TRAFFIC CONSIDERATIONS

Where appropriate, ensure that the Contractor provides adequate maintenance of traffic through the construction zone (e.g., crossovers for construction equipment and public vehicles). Construction traffic should not be permitted on the pavement until the sawing and sealing operation has been completed. The pavement shall not be opened to traffic until the test specimens obtained during the placement of the concrete indicate that the pavement has reached its minimum specified strength.

412.11 GUIDELINES FOR INTERPRETING NON-STANDARD READINGS USING THE MIT-SCAN-2

When verifying dowel placement using the MIT-Scan-2 for dowels placed using a dowel bar inserter (DBI) machine or when using dowel baskets, some detailed exceptions have been observed:

A common cause of incorrect dowel bar placement is incorrect sawing of the transverse joint. The specification requires: The Contractor shall detail his methodology for ensuring correct marking of dowel bar insertion points and correct sawing of the joints. There may be instances with dowel baskets where additional analysis and engineering judgment may be required to make a final determination of the acceptability of the placed dowel bars.

1. The Engineer is encouraged to discuss the proposed dowel placement and potential MIT-Scan-2 reading exceptions at the Pre-construction or Pre-pave conferences to determine a method of handling these conditions.

2. This guidance is attached for your reference. Before applying these guidelines, ensure the MIT-Scan-2 device has been calibrated properly and settings entered correctly.

Non-Standard
Readings Using MIT-S

SECTION 420
GEOSYNTHETICS

420.1 PRELIMINARY CONSIDERATIONS

Geosynthetics (e.g., geotextiles, geogrids, geomembranes) are specified for many types of applications. For the material to function as intended, it is important that the specified type of material be furnished and properly placed. Before the application of geosynthetics, consider the following guidelines:

1. Contract Plans and Specifications. Review the Contract, including *Special Provisions*, with respect to the type of application, limits of treatment, and material, construction, measurement, and payment requirements.

2. Material Considerations. Various types of geosynthetics are available for different applications. Check the material delivered for conformance.

3. Geosynthestic Technician. Where required for paving applications, verify that a technician from the geotextile supplier is present for technical advice.

4. Surface Preparation/Tearing Considerations. Pay particular attention to the surface upon which the geosynthetic will be placed. The surface should be reasonably smooth to a grade that conforms to the intended application. Observe the surface for items that could tear the material. In addition, the cover material should be placed carefully to avoid ruptures and tears.

420.2 INSPECTION GUIDELINES

420.2.1 Paving Applications

Geotextiles are typically used in paving applications for crack reduction. Consider the following guidelines:

1. Surface Preparation. Before the material is laid, verify that the surface is properly cleaned. Power brooms are generally used for this purpose.

2. Asphalt Cement Binder. After cleaning and before the fabric is laid, check that the asphalt cement is applied at the specified temperature and rate, and is the same grade as the asphalt cement used for item 403.

3. Fabric Placement. Immediately after the application of asphalt cement, the fabric should be laid. Verify that the geotextile fabric is placed within the limits of the Contract Plans with proper overlaps at joints and without wrinkles or tearing. No more fabric than that which can be covered by a subsequent asphalt mix course should be applied during the work day.

4. Traffic Considerations. To avoid damage, check to ensure that equipment does not park or make sudden starts, stops, or short turns on the fabric. Traffic on the fabric should be minimal.

420.2.2 Impervious Lining Applications

Geomembranes are typically used for impervious lining applications. Check to ensure that the geomembrane is loosely laid to avoid rupture and that wrinkles are smoothed where practical. Verify that field lap joints are properly placed and that the joint contact surfaces are cleaned and treated with bonding adhesive as specified. Enforce the provisions of the Contract with respect to any needed repairs.

420.2.3 Erosion Control and Drainage Applications

Geotextiles are typically used for erosion control and drainage applications. The manner in which the geotextile is laid should minimize displacement of the fabric by water. Check that the fabric is loosely laid in the direction of water flow and anchored as required. Verify that trenching is placed at the top of slopes where designated on the Contract Plans. Check joint overlaps and sewn seams for conformance.

420.2.4 Subgrade Applications

Geotextiles and geogrids are typically used in subgrade applications. Prior to placement, inspect the prepared surface for acceptability. Consider the following guidelines:

1. Fabric Placement. The fabric should be placed in the direction of construction traffic in a relatively stretched condition without wrinkles or folds and secured as specified. Folds that are in the direction of construction traffic are acceptable on curved sections. Do not allow the fabric to be dragged across the subgrade. Verify overlaps at joints for conformance and inspect the fabric for damage prior to placement of cover material. Enforce the Contract provisions with respect to any needed repairs.

2. Cover Placement/Compaction. Verify that the placement, grading, and compaction operation for the first lift of cover material conforms to specified requirements. Watch for damage to the fabric caused by the compaction operation and ensure that needed repairs are made.

3. Traffic Considerations. Enforce the provisions with respect to equipment traffic (e.g., minimum thickness of cover, type and weight limitations). In general, equipment should not make turning movements on the first lift of compacted cover. Watch for fabric damage and subgrade rutting and ensure that any needed repairs are made.

420.2.5 Landscape Applications

Geotextile fabric is typically used for weed barriers in mulched landscape applications. Prior to placement, verify that the soil has been properly prepared and graded. Check to ensure that the fabric is placed loosely, lapped in the direction of water flow, and anchored as required. Where designated on the Contract Plans, verify check slots are provided at the top of slopes. Also check for the installation of metal landscape borders where required.