

Section 10 – Geotechnical and Roadway Pavements

Geotechnical Investigations

Geotechnical investigations are provided and available in the Reference Documents. See project website at <http://www.coloradodot.info/projects/us6overgarrison>.

The Contractor has, prior to submitting its Proposal, in accordance with prudent and generally accepted engineering and construction practices, reviewed the boring logs provided in the Reference and Contract Documents, inspected and examined the Site and surrounding locations, and undertaken other appropriate activities sufficient to familiarize itself with surface conditions and subsurface conditions affecting the Project, to the extent the Contractor deemed necessary or advisable for submittal of a Proposal. As a result of such review, inspection, examination and other activities, the Contractor is familiar with and accepts the physical requirements of the Work. The Contractor acknowledges and agrees that changes in conditions at the Site may occur after the Proposal Due Date, and that the Contractor shall not be entitled to any Change Order. Before commencing any Work on a particular aspect of the Project, the Contractor shall verify all governing dimensions and conditions at the Site and shall examine all adjoining work, which may have an impact on such Work. The Contractor shall be responsible for ensuring that the Design Documents and Construction Documents accurately depict all governing and adjoining dimensions and conditions.

The Contractor shall be responsible for any supplemental subsurface investigation necessary to complete the Work. Geotechnical investigations shall comply with the requirements of the CDOT Field Materials Manual, the CDOT Pavement Design Manual, and the AASHTO LRFD Bridge Design Specifications, Section 10 in effect at the time of bidding. All supplemental investigations made by the Contractor shall be documented in a geotechnical investigation report and submitted to the CDOT Project Engineer and CDOT Geotechnical Program for Acceptance. Supplemental investigations (geotechnical and pavement) must be signed and stamped by a professional engineer, licensed in the State of Colorado, and with a CDOT-qualified firm.

Roadway Embankment Requirements

The existing embankment material is classified as AASHTO A-6 and A-7-6 material with R-Value test results of approximately 5. Imported roadway embankment material shall have a minimum R-Value of 10, meet soil embankment criteria of Standard Specifications Section 203.03, and be compatible with structures constructed on and adjacent to the embankment.

Roadway Pavement Analysis and Design

CDOT has performed the pavement design to determine the pavement type, SMA and HMA grading, design gyrations, binder requirements, pavement thickness, and minimum sub-grade stabilization requirements for new pavement construction. The Contractor shall be responsible for all other aspects of pavement design.

Construction of multiple-lift overlay over existing pavement to achieve final pavement grade

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shall require submittal of a pavement design by the Contractor, in conformance with the CDOT 2015 M-E Pavement Design Manual, for acceptance by CDOT.

Pavement Structure

The Pavement Structure is defined as the thickness of the Stone Matrix Asphalt (SMA), Hot Mix Asphalt (HMA) plus the Aggregate Base Course (ABC). See Contract Documents for Pavement Structure recommendation report.

Construction Requirements

The Contractor shall construct the Pavement Structure in accordance with the Technical Requirements.

All pavement shall be constructed full width, including inside and outside shoulders.

Any layer of HMA that is to have a succeeding layer placed thereon shall be completed to full width before the succeeding layer is placed.

Roadway Pavement Types

Flexible pavement consisting of SMA for the top lift and HMA for the intermediate and bottom lifts will be required on US 6.

Smoothness Requirements

Smoothness requirements shall be HRI Category II according to Section 105.07 of the Standard Specifications.

New Hot Mix Asphalt Construction

Full depth pavement reconstruction is required for US 6.

The Contractor shall use SMA for the top lift and HMA (Grading S) (100)(PG 64-22) for the roadway HMA pavement. The Contractor shall use SMA on the bridge surface. Pavement shall comply with the specifications in this Section.

The Contractor shall use the following lift thicknesses when placing HMA pavement on prepared subgrade and base course.

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Table 10.1 – Recommended HMA Pavement Lift Summary (US 6 EB and WB)

Lift Description	Lift Thickness (inches)	Grading	Binder
Top Lift	2	SMA(Fibers)(Asphalt)	PG 76-28
Intermediate Lift 3	2.25	S	PG 64-22
Intermediate Lift 2	2.25	S	PG 64-22
Intermediate Lift 1	2.5	S	PG 64-22
Bottom Lift	3.0	S	PG 64-22

Table 10.2 – Recommended HMA Pavement Lift Summary (US 6 EB Off-Ramp)

Lift Description	Lift Thickness (inches)	Grading	Binder
Top Lift	2	SMA(Fibers)(Asphalt)	PG 76-28
Intermediate Lift 2	2.5	S	PG 64-22
Intermediate Lift 1	2.5	S	PG 64-22
Bottom Lift	3.0	S	PG 64-22

Bridge deck paving shall be placed to a compacted thickness of 3 inches, or as otherwise indicated on the plans. A waterproofing membrane shall be used beneath the bridge deck paving.

The Contractor shall use HMA (Grading S)(100)(PG 64-22) for any leveling and patching required.

The nominal aggregate size of the SMA shall be ½-inch. All references to SMA shall be taken as Stone Matrix Asphalt (Fibers)(Asphalt) or SMA(Fibers)(Asphalt). SMA shall not contain any reclaimed asphalt pavement.

The lift thickness of the intermediate and bottom lifts shall follow the guidelines established in Table 3.7 of the 2015 CDOT Pavement Design Manual. The thickness of each overlying lift shall be equal to or less than the thickness of the lift below. Any flexible pavement alternative offered by the contractor shall indicate the type of mix, asphalt binder, and thickness of all lifts that comprise the pavement section.

The contractor shall be responsible for all detour pavements.

Pavement Thickness

The Contractor shall construct the Pavement Section to the thickness requirements shown on the plans for the Project, as set forth in the Table below:

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Location	Required Pavement Section Thickness (inches)			Pavement Smoothness Category (i)
	SMA plus HMA	ABC Class 6		
US 6 (Full depth)	12	6		HRI Category II
EB US 6 Off-Ramp at Garrison Street	10	6		HRI Category II
Bridge	3	NA		NA

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Deliverables

Deliverable	Acceptance or Approval	Schedule
Technical Memorandum that indicates the Contractor has reviewed and accepts the provided Geotechnical Reports and that the Contractor has no exceptions and/or the Contractor provides the following changes. Technical Memorandum must be stamped by the Contractor’s Design Professional Engineer	Acceptance	Prior to Design
Supplemental Geotechnical Investigations	Acceptance	N/A

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Project Special Provisions

REVISION OF SECTION 106 CONFORMITY TO THE CONTRACT OF HOT MIX ASPHALT

Section 106 of the Standard Special Provisions is hereby revised for this project as follows:

Subsection 106.05 shall include the following:

For this project, Contractor process control testing of hot mix asphalt is mandatory.

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REVISION OF SECTION 304 AGGREGATE BASE COURSE

Section 304 of the Standard Specifications is hereby revised for this project as follows:

Subsection 304.02 shall include the following:

Materials for the base course shall be Aggregate Base Course (Class 6) as shown in subsection 703.03.

The aggregate base course (Class 6) shall meet the gradation requirements and have a resistance value of at least 78 respectively when tested by the Hveem Stabilometer method.

Recycled Asphalt Pavement (RAP) may not be used as ABC under HMA pavement.

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REVISION OF SECTION 401 PLANT MIX PAVEMENT COMPACTION (PNEUMATIC TIRE ROLLERS)

Section 401 of the Standard Specifications is hereby revised for this project as follows:

In subsection 401.17, first paragraph, delete the second sentence and replace with the following:

Both steel wheel and pneumatic tire rollers will be required on this project. If the Contractor has demonstrated that all of the manufacturer's recommendations were followed and the pneumatic tire roller is detrimental to the finished surface of the HMA, the Engineer, in cooperation with the Contractor and the Region Materials Engineer, may waive the pneumatic tire roller requirement. Pnuematic tire rollers shall not be used on SMA pavement. Steel wheel rollers shall not be used in vibratory mode when compacting SMA on bridge decks.

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REVISION OF SECTION 304 & 403 WEIGHT TICKET COLLECTION

Section 304 and 403 of the Standard Specifications is hereby revised for this project as follows:

Subsection 304.08 and 403.05 shall include the following:

The Contractor shall collect the original scale ticket on each load when it is delivered to the project site, and ensure that the information required in subsection 109.01 is shown on each ticket. The Contractor's representative assigned this project function shall not be responsible for any other duties. The scale tickets shall be available on site for CDOT personnel to inspect.

At the close of each workday, the Contractor shall provide the Engineer envelopes, which contain that day's signed tickets and the following:

1. On each envelope: Project number, date of paving, type of material, daily total, and cumulative total.
2. One of the following:
 - a. Two adding machine tape tabulations of the weight tickets with corresponding totals run and signed by different persons.
 - b. One signed adding machine tape tabulation of the weight tickets that has been checked and signed by a second person.
 - c. Signed check tape of computer scale tickets that have a cumulative total. These scale tickets shall be consecutive and without voids adjustments.
3. A listing of any overweight loads on the envelope, including ticket numbers and amount over legal limit.
4. A comparison of the actual yield for each day's placement to the theoretical yield. Theoretical yield shall be based on the actual area paved, the planned thickness, and the actual density of the mixture being placed. Any variance greater than +2.5% shall be indicated on the envelope and a written explanation included.
5. Asphalt Paving Inspector Daily Report (CDOT Form 282) shall be completed, in its entirety, by the contractor as work progresses.

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REVISION OF SECTION 304 & 403 WEIGHT TICKET COLLECTION

Each day, the Contractor shall provide a vehicle identification sheet that contains the following information for each vehicle:

- (1) Vehicle number
- (2) Length
- (3) Tare weight (Tractor and Trailer Combination – Tare Separately)
- (4) Number of axles
- (5) Distance between extreme axles
- (6) All other information required to determine legal weight
- (7) Legal weight limit

Should the Contractor fail to weigh each vehicle daily, the Engineer may reject HMA loads until the Contractor complies with these requirements. All costs incidental to the foregoing requirements shall be included in the original contract prices for the project.

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**REVISION OF SECTION 401 AND 403
 HOT MIX ASPHALT**

Section 401 of the Standard Specifications is hereby revised for this project as follows:

In Subsection 401.22 under Basis Of Payment, delete the fifth paragraph.

Section 403 of the Standard Specifications is hereby revised for this project as follows:

Subsection 403.02 shall include the following:

The design mix for hot mix asphalt shall conform to the following:

TABLE 403-1

	TEST METHOD	VALUE FOR PROPERTY
Grading		(S), (-)
Air Voids, percent at N(des)	CPL 5115	3.5-4.5
Lab Compaction (Revolutions) N(des)	CPL 5115	100
Stability, minimum	CPL 5106	30
Aggregate retained on the No. 4 sieve with at least 2 Mechanically Induced fractured faces, % minimum	CP 45	70
Accelerated Moisture Susceptibility Tensile Strength Ratio (Lottman), minimum	CPL 5109 Method B	70
Minimum Dry Split Tensile Strength, psi (kPa)	CPL 5109 Method B	30 (205)
Grade of Asphalt Cement, Top Layer		PG 76-28
Grade of Asphalt Cement, Layers Below Top		PG 64-22
Voids in the Mineral Aggregate (VMA), % min	CP 48	See TABLE 403-2
Voids Filled with Asphalt (VFA), %	AI MS-2	65-80
Dust to Asphalt Ratio Fine Gradation	CP-50	0.6 — 1.2
Coarse Gradation	CP-50	0.8 — 1.6

Note: AI MS-2 = Asphalt Institute Manual Series 2

Note: The current version of CPL 5115 is available from the Region Materials Engineer

Note: Mixes with gradations having less than 40% passing the No. 4 sieve shall be approached with caution because of constructability problems.

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**REVISION OF SECTIONS 401 AND 403
 HOT MIX ASPHALT**

Note: Gradations for mixes with a nominal maximum aggregate size of one-inch or larger are considered a coarse gradation if they pass below the maximum density line at the #4 screen.

Gradations for mixes with a nominal maximum aggregate size of ¾ inch or smaller are considered a coarse gradation if they pass below the maximum density line at the #8 screen.

All mix designs shall be run with a gyratory compaction angle of 1.25 degrees and properties must satisfy Table 403-1. CDOT Form #43 will establish construction targets for Asphalt Cement and all mix properties at Air Voids up to 1.0% below the mix design optimum.

TABLE 403-2
 Minimum Voids in the Mineral Aggregate (VMA)

Nominal Maximum Size * Inches (mm)		***Design Air Voids **		
		3.5%	4.0%	4.5%
1 1/2	(37.5)	11.6	11.7	11.8
1	(25.0)	12.6	12.7	12.8
3/4	(19.0)	13.6	13.7	13.8
1/2	(12.5)	14.6	14.7	14.8
3/8	(9.5)	15.6	15.7	15.8

* The nominal size is defined as one sieve larger than the first sieve to retain more than 10%

** Interpolate specified VMA values for design air voids between those listed.

*** Extrapolate specified VMA values for production air voids beyond those listed.

The Contractor shall prepare a quality control plan outlining the steps taken to minimize segregation of HMA. This plan shall be submitted to the Engineer and approved prior to beginning the paving operations. When the Engineer determines that segregation is unacceptable, the paving shall stop and the cause of segregation shall be corrected before paving operations will be allowed to resume.

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REVISION OF SECTIONS 401 AND 403 HOT MIX ASPHALT

CDOT approved Warm Mix Asphalt (WMA) may be allowed on this project in accordance with CP-59. Unique requirements for WMA design, production and acceptance testing as documented during CDOT WMA approval shall be submitted and approved prior to creation of the Form 43 and before any WMA production on the project. Any delays to the project due to WMA submittal and review shall be considered within the Contractor's control and will be non-excusable.

A minimum of one percent hydrated lime by mass (weight) of the combined aggregate shall be added to the aggregate for all hot mix asphalt.

Acceptance samples shall be taken at the location specified in either Method B or C of CP 41, as determined by the Region Construction and Materials personnel.

Aggregate, additives, hydrated lime, and all other work necessary to complete each Hot Mix Asphalt item will not be paid for separately but shall be included in the Work.

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REVISION OF SECTION 401 AND 703

Sections 401 and 703 of the Standard Specifications are hereby revised for this Project as follows:

Subsection 401.02 shall include the following:

Recycled Asphalt Pavement (RAP) shall not be used in Stone Matrix Asphalt (SMA) mix.

Subsection 401.09 shall include the following:

Each SMA load shall be completely covered and securely fastened with a full tarp.

Subsection 401.16 shall include the following:

The SMA mixture shall be transported and placed on the roadway without drain-down or flushing. All flushed areas behind the paver shall be removed immediately upon discovery. If more than 50 square feet of flushed SMA pavement is ordered removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the flushing has been found and corrected. The Engineer shall designate the depth and area of all flushed areas requiring removal and replacement. All costs associated with the removal and replacement of the flushed areas shall be at the Contractor's expense.

Subsection 401.17 shall include the following:

Rollers shall not be used in a vibratory mode on SMA unless they are first used successfully in the demonstration control strip specified in subsection 403.03. Pneumatic wheel rollers shall not be used on SMA mix.

The relative compaction for all SMA mixtures will be measured from roadway cores in accordance with CP 44, Method B, unless the SMA mixture is being placed on a structure (bridge deck) in which case nuclear gauge measurements may be used. When cores are used, the Contractor shall provide all labor and equipment for the coring operation and filling the core holes. When nuclear density gauges are used, the tests will be performed in accordance with CP 81 and CP 82.

In-place density for SMA not placed on a bridge shall be 93 to 97% of the SMA mix maximum specific gravity as measured according to CP 51.

At a minimum frequency of once per day, the in-place density for SMA placed on the bridge deck shall be measured according to CP 81. The in-place density of SMA shall be a minimum of 94 percent of the SMA mix maximum specific gravity as measured

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according to CP 51

Subsection 401.22 shall include the following:

The specifications for gradation acceptance shall be applied for all SMA placed on the project.

Subsection 703.06 shall include the following:

Mineral filler for the Stone Matrix Asphalt pavement shall be limestone dust and shall meet the requirements of this subsection and the following:
 Plasticity Index (AASHTO T90) 4% Maximum
 The Contractor shall submit hydrometer analysis (AASHTO T88) for the mineral filler used in the SMA mix.

Section 403 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 403.01 shall include the following:

This work includes placing a Stone Matrix Asphalt (SMA) pavement as shown on the plans.

Subsection 403.02 shall include the following:

The SMA gradation for this Project shall be ½ inch.
 Mixture design and field control testing of SMA shall be performed using SuperPave (CPL 5115, 100 Gyration)

The Contractor shall submit a mix design meeting the appropriate specification requirements for the following to CDOT at the Pre-paving Conference:
 The SuperPave SMA mix design shall conform to the requirements of Table 403-1a:

Table 403-1a		
Property	Test Method	Value for SMA
Air Voids, percent at: N(Design)	CPL 5115	3.0 – 4.0
Lab compaction (Revolutions) N(Design)	CPL 5115	100
Accelerated Moisture Susceptibility, tensile strength Ratio, (Lottman), minimum	CPL 5109, Method B	70
Minimum Dry Split Tensile Strength, psi	CPL 5109, Method B	30
Grade of Asphalt Cement		PG 76-28
Voids in the Mineral Aggregate (VMA) %, minimum	CP 48	17
Draindown at Production	AASHTO T305	0.3 maximum

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Table 403-1a		
Property	Test Method	Value for SMA
Temperature % VCA ¹ _{MIX}	AASHTO R 46	Less than VCA _{DRC} ²
Note: The current version of CPL 5115 is available from CDOT Note: Copies of AASHTO R 46 and M 325 can be obtained from CDOT Note: ¹ Voids in the Coarse Aggregate Note: ² Dry-rodded condition		

Form 43 will establish construction targets for asphalt cement and all mix properties at air voids up to 1.0% below the mix design optimum.

A minimum of 1% hydrated lime by weight of the combined aggregate shall be added to the aggregate for all Stone Matrix Asphalt.

The SMA mix design must be Approved by CDOT before any pavement is placed on the project. In addition, the Contractor shall provide field control testing during production of the SMA mix and for the demonstration control strip. The Contractor shall perform the following tests and provide the results to CDOT during production:

For the SMA mix design, the Contractor shall perform the following tests and provide the results to the Engineer during production:

Superpave Mix Property	Frequency
Draindown (AASHTO T 305)	1/1000 tons or fraction thereof
Percent Voids in the total mix @ N _(design)	1/1000 tons or fraction thereof
VMA (Percent Voids in the Mineral Aggregate) @ N _(design)	1/1000 tons or fraction thereof
Lottman, CPL 5109, Method B	1/5000 tons or fraction thereof
Dry Tensile Strength, CPL 5109	1/5000 tons or fraction thereof
Percent AC & Aggregate Gradation CP 5120	1/1000 tons or fraction thereof

Subsection 403.03 shall include the following:

The mineral filler for SMA shall be stored in a separate silo and added automatically in the correct proportion. The mineral filler addition equipment shall be electronically or mechanically interlocked to the aggregate feed sensors so that the proper amount of mineral filler is added whenever SMA is produced.

The SMA mineral filler shall be added at the same point the asphalt cement is added to the aggregate.

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Tack coat between the existing pavement and Stone Matrix Asphalt pavement shall be placed at a rate between 0.03 and 0.05 gallons per square yard.

Before proceeding with SMA placement, the Contractor shall demonstrate the ability to produce and place a satisfactory mix in a Demonstration Control Strip (DCS). The Contractor will coordinate with the Quality Control Manager on the proposed location of the DCS. The DCS shall consist of a minimum quantity of 500 tons placed in one lane, full width. Within the last 200 tons of SMA placed in the DCS, the Contractor and CDOT shall determine properties (VMA, Voids, in-place density, AC content, and gradation of the project produced SMA mix used in the DCS and provide the results to the Contractor's Quality Control Manager. The Contractor may proceed with full production if all mixture properties are within the specified tolerances and the project compaction is established and approved by CDOT.

If a DCS will be placed on the actual roadway, it shall be full width and shall extend for a minimum distance of 150 feet. The location of the DCS shall be no closer than 100 feet to the expansion joint of any bridge with concurrent deck rehabilitation or construction. To determine the in-place density and roller pattern, one core shall be taken at three random locations within the last 200 tons of the DCS. As part of the Contractor's QMP, the coring locations shall be determined using a stratified random sampling process. The cores shall be immediately submitted to the Contractor's Quality Manager and will be used for determining acceptance of the DCS. Densities of the random samples will be determined by cores according to CP 44. Coring shall be performed by the Contractor under the Quality Manager's observation.

The DCS will be designated as a separate process.

Subsection 403.04 shall include the following:

Stone Matrix Asphalt will be measured by the actual number of tons that are completed and accepted.

Subsection 403.05 shall include the following:

Mix design, furnishing, hauling, preparing, and placing all materials, including aggregates, asphalt cement, limestone dust, hydrated lime, tack coat, and approved demonstration control strip; labor, equipment tools, setting of lines and guides where specified, and all other work necessary to complete the item will not be paid for separately but shall be included in the work.

Stone Matrix Asphalt will be measured by the actual number of tons that are completed and accepted.

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REVISION OF SECTIONS 403 AND 620 HOT MIX ASPHALT TESTING, IGNITION FURNACE

If Reclaimed Asphalt Pavement is to be included in the Hot Mix Asphalt supplied on this project then the following shall apply:

Section 620.03 of the Standard Specifications is hereby revised for this project as follows:

In addition to the details shown in the plans for this project the field laboratory Class 2 shall include a forced air ignition furnace as described in CPL 5120. The Forced Air Ignition Furnace shall be installed per manufacturer's recommendations.

The 403 Pay Item of the Quality Assurance Schedule in the Field Materials Manual is hereby revised for this project as follows:

Asphalt content shall be measured following CPL 5120. Residual aggregate obtained by this method shall be used for gradation analysis according to CP 31.