10.0 GEOTECHNICAL, ROADWAY PAVEMENTS, AND STRUCTURE FOUNDATIONS

10.1 Design Requirements

10.1.1 Geotechnical Investigations

Geotechnical investigations performed by CDOT are provided in Book 3~~-~~, Section 10~~- Reference Documents~~.

The Contractor shall be responsible for any supplemental subsurface investigation necessary to complete the Work. Geotechnical investigations shall comply with the requirements of the 2014 CDOT Field Materials Manual, the 2015 CDOT M-E Pavement Design Manual~~2015 CDOT Pavement Design Manual~~, Table 10.1 Geotechnical Boring Depth and Frequency Table and any other applicable standards necessary to perform the Work. All supplemental investigations made by the Contractor shall be documented in geotechnical investigation reports of similar format as those referenced geotechnical documents and submitted to CDOT for review and comment prior to Acceptance within 30 days following completion of the fieldwork. All supplemental investigations made by the Contractor for non-CDOT roadways shall be documented in separate Geotechnical Investigation Reports according to the maintaining entity and submitted to CDOT for Acceptance. No additional compensation will be provided for any additional costs for subsurface exploration work within areas of contaminated soil or groundwater.

Table 10.1 – Geotechnical Boring Depth and Frequency Table

		MINIMUM NO. OF BORINGS	BORING DEPTH
Foundations	Drilled Shaft	1 per substructure unit < 100 ft width 2 per substructure unit > 100 ft width	10 ft into bedrock (N ≥ 50) or 3D below tip elevation.
	Driven Piles		10 ft into bedrock (N ≥ 50) or 20 ft below tip elevation.
	Spread Footing		2B where L< 2B, 4B where L > 2B and interpolate for L between 2B and 4B or 10 feet into bedrock.
	Concrete Box Culvert	1 at each end and every 100 ft along axis	3H or 10 feet into bedrock (N ≥ 50).
Walls	MSE/Cast in Place	1 at each end and every 200 ft along wall	2H or 10 feet into bedrock (N ≥ 50).
	Tieback Anchor	1 in anchorage zone spaced every 200 ft along wall	
	Soil Nail	1 in nail zone 1H from wall every 200 ft along wall	
Landslide		3 along center of slide. Place at least one boring above and below sliding area.	10 ft below slide failure into competent stratum. Slide failure plane is rarely greater than slide width.
Pavement Settling		Determined by size and extent of distressed area.	Determined by size and extent of distressed area.
Pavement Heaving		Determined by size and extent of distressed area.	20 ft.
Material Soil Survey	Pavement realignment or widening	1 every 1,000 ft along centerline or determined by Materials Engineer.	Minimum of 5 ft below the top of proposed pavement elevation or determined by Materials Engineer.
	Cut sections – road widening	1 at each end of cut section and every 500 ft or determined by Materials Engineer.	Minimum of 5 ft below the top of proposed pavement elevation or determined by Materials Engineer.
	Cut sections – new alignment	1 at each end of cut section on opposite shoulders. If cut >20 ft, 1 boring through deepest section of cut on centerline.	Minimum of 5 ft below the top of proposed pavement elevation or determined by Materials Engineer.
	Embankment fill >20 ft – new alignment	1 at centerline at deepest fill area.	Minimum of 5 ft below the top of proposed pavement elevation or determined by Materials Engineer.

Modified from *Checklist And Guidelines For Review Of Geotechnical Reports And Preliminary Plans And Specifications*, Publication No. FHWA ED-88-053, Table 2; *CDOT Field Materials Manual*, Chapter 200; *AASHTO LRFD Bridge Design Specifications*, 4th Edition, Table 10.4.2-1; and *Landslides: Investigations and Mitigations*, TRB Special Report 247, Chapter 2.

D – Diameter B – Footing width H – Wall height L – Footing length N – Blow count values in 12 inches

10.2 Construction Requirements

10.2.1 Pavement Structure

The Pavement Structure is defined as the combination of one or more of the following courses placed on a subgrade to support and distribute the traffic load to the roadbed:

- Subbase. The layer or layers of specified or selected material placed on a subgrade to support a base course, surface course, or both.
- Base Course. The layer or layers of specified or selected material placed on a subbase or a subgrade to support a surface course.
- Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load. The top layer of the Surface Course resists skidding, traffic abrasion, and the disintegrating effects of climate.

To provide for adequate sulfate resistance, all concrete supplied to the project shall be designed for Class 2, Severity of Sulfate Exposure. The Contractor may, at their expense, have a certified laboratory test the subgrade as per the 2014 CDOT Field Materials Manual. Testing shall be at the same schedule and frequency as required for preliminary soil survey. The Contractor may propose a different Class of Exposure for the Project based on the test results. Concrete for foundation elements shall be designed for Class 2, Severity of Sulfate Exposure.

10.2.2 Roadway Pavement Analysis and Design

CDOT has performed the pavement design and Life Cycle Cost Analysis to determine the pavement type, thickness, and minimum sub-grade stabilization requirements that will be used on this project. Alternative Technical Concepts (ATCs) involving a reduction in thickness or change in type of the materials included in the pavement section elements; including Portland Cement Concrete Pavement (PCCP) and Hot Mix Asphalt (HMA), Aggregate Base Course (ABC), and minimum subgrade thicknesses, classifications, and support values, will be not considered for this project. The Contractor shall be responsible for all other aspects of pavement design, including the HMA Mix Design, except as otherwise provided for in the Contract Documents.

Rigid pavement designs consist of Portland Cement Concrete Pavement (PCCP), with load transfer devices and tied shoulders, over 6 inches of Aggregate Base Course Class 6 (ABC Class 6) and underlain by at least 24 inches of material with an R-value greater than or equal to the minimum R-value specified in Book 2, Section ~~11~~11.1.3.2~~, Table 11.1~~. Flexible pavement designs consist of two inches of Stone Matrix Asphalt (Fibers) (Asphalt) with Hot Mix Asphalt (Grading SX) (100) (PG 64-22) utilized for the rest of the pavement depth over 6 inches of ABC Class 6 and underlain by a minimum of 24 inches of material with an R-value greater than or equal to the minimum R-value specified in Book 2, Section 11.1.3.2~~11, Table 11.1~~. The pavement shall be uniform for all of the segments identified. All pavement shall be constructed full width, include inside and outside shoulders, if any.

Location descriptions, Pavement Type (Rigid or Flexible) and Pavement Thickness for Project Roadways are shown in Table 10.2.2 – Pavement Design Parameters. Construction limits ~~(beginning and ending stationing)~~for Ramp Pavements begin at the physical gore and end at the

flowline for the cross street terminal. ~~for location descriptions of roadways, along with the pavement type are depicted on Exhibit A to Book 2, Section 10.~~

Table 10.2.2 - Pavement Design Parameters				
Roadway and (Number of Design Lanes)	Pavement Type	Design Life (years)	Daily Truck Volume	Pavement Thickness (inches)
Mainline I-25 NB & SB	Rigid	30	11,975	9.5
NB Exit Ramp	Rigid	30	1,475	8.5
NB Entrance Ramp	Rigid	30	1,404	8.5
SB Exit Ramp	Rigid	30	1,406	8.5
SB Entrance Ramp	Rigid	30	1,366	8.5
US 24/Cimarron East of I-25	Rigid/Flexible*	30/20	1,230	8.5/7.0
US 24/Cimarron Under I-25	Rigid	30	1,995	8.5
US 24/Cimarron West of I-25	Rigid/Flexible*	30/20	2,603	9.0/8.5
Mainline I-25 NB & SB White-topping	Rigid	30	11,975	8.0
Maihnline I-25 NB & SB Mill & Overlay	Flexible*	20	11,975	4.5
Mainline I-25 NB & SB Transition Widening	Flexible*	20	11,975	10”

* Flexible will consist of 2" SMA over S(100) PG 64-22 lower lifts

Where applicable PCCP on I-25, Ramps, and US 24 shall extend to the end of the curb return on intersection side streets. All PCCP shall be doweled and tied per CDOT M-412 unless otherwise specified by CDOT. The Contractor shall prepare a pavement jointing plan per CDOT M-412, the 2015 CDOT M-E Pavement Design Manual, and industry best practices. The jointing plan shall be submitted to CDOT for approval with the preliminary design documents.

The top 2 inches of all flexible pavement alternatives shall be Stone Matrix Asphalt (Fibers) (Asphalt). The nominal maximum aggregate size of the SMA shall be ½ inch. All references to SMA shall be taken to be Stone Matrix Asphalt (Fibers)(Asphalt) or SMA (Fibers)(Asphalt). Stone Matrix Asphalt (Fibers) (Asphalt) shall not contain any reclaimed asphalt pavement. The intermediate and bottom lifts of asphalt shall be HMA (Grading S) (100) (PG 64-22). The lift breakdown of the intermediate and bottom lifts shall follow the guidelines established in Table ~~3~~6.7 of the 2015 CDOT M-E Pavement Design ~~Guide~~Manual. The thickness of each overlying lift shall be equal to or less than the thickness of the lift directly below. ~~Any flexible pavement alternative offered by the contractor shall indicate the type of asphalt and thickness of all lifts that comprise the pavement section.~~

Milling for mill and overlay sections shall be a minimum of 2” and shall result in a total HMA thickness of at least 10” for I-25 and a minimum HMA thickness in accordance with Table 10.2.2 for US-24 and Cimarron Street.

The Contractor shall be responsible for providing and maintaining detour pavements in a safe and serviceable condition, subject to CDOT approval. ~~The Contractor shall submit pavement designs for all detour pavements for CDOT Acceptance.~~ Detour pavements shall utilize at a minimum grading, gyrations, and binder equivalent to Hot Mix Asphalt (Grading S) (100) (PG 64-22). Where detour pavement abuts existing pavement which has a base of aggregate base course, the detour must include a layer of aggregate base course which shall serve to convey potential underpavement drainage away from the permanent pavement. The Contractor shall be responsible for maintenance of all detour pavements.

10.2.3 Trail Pavement Mix Designs, Types, Thickness Requirements and Sections

The Contractor shall present mix designs for concrete 3 weeks prior to concrete placement to CDOT for Approval.

The Contractor shall construct the trail concrete pavement to the thickness requirements for the Project, as set forth in the Table 10.2.3 below:

Table 10.2.3 – Trail Pavement Design Parameters			
Location	Required Trail Pavement Section Thickness (inches)		
	Concrete	Aggregate Base Course (Class 6)	Embankment
Greenway Trail from Existing Midland Trail Connection to Bear Creek Connection (West side of Monument Creek)	-	6”	See Section 11
Greenway Trail (East side of Monument Creek)	6” or 5” with Fiber Mesh	-	See Section 11
Midland Trail along Fountain Creek	6” or 5” with Fiber Mesh	-	See Section 11
Connection from Midland Creek at Fountain Creek to Existing Midland Trail along S. Chestnut St.	6” or 5” with Fiber Mesh	-	See Section 11

10.2.3 Existing Pavement Sections

If the existing pavement section of any roadway is modified as part of the Work, the Contractor shall demonstrate through a pavement section analysis that the modified pavement section will serve a 20-yr design life. If the modified section does not meet a 20-yr design life the Contractor shall design and construct a section to meet this requirement. The Contractor shall submit to CDOT this analysis and design for Approval prior to Release for Construction drawings.

10.2.4 Alternate Pavement Designs

Intentionally left blank.

10.2.5 Non-CDOT Roadways Pavement Designs

Intentionally left blank.

10.2.6 Structure Foundation Analysis and Design

Intentionally left blank.

10.3 Construction Requirements

The Contractor shall construct the PCCP, SMA, HMA, and all other paved surfaces in accordance with the requirements of the Contract Documents. Construction of Contractor-designed permanent paved surfaces shall not commence until the pavement design has been Approved by CDOT.

Where it is required to cut existing pavement, the cutting shall be done to a neat work line full depth with a pavement-cutting saw or other method as approved by the CDOT.

At no time should the blunt end of guardrail, barrier, end treatment, etc. be exposed to oncoming traffic.

The Contractor shall be responsible for constructing Safety Edge as specified in Book 2, Section 13.3.6.

Any curb and gutter, which is to remain and is damaged as a result of the contractor's operation, shall be replaced at the contractor's expense.

10.3.1 Roadway Pavement Construction Requirements

A minimum of thirty days prior to the proposed use of any pavement on the Project, a Pre-paving Conference shall be conducted. At the Pre-paving Conference, the Contractor shall present to CDOT for Approval mix designs for SMA, HMA, and PCCP, as well as final jointing plans for PCCP.

10.3.2 Roadway Pavement Types and Thickness Requirements

10.3.2.1 Full-Depth Asphalt Pavement

A tack coat is required between layers of bituminous pavement. Diluted emulsified asphalt for tack coat shall consist of 1 part emulsified asphalt and 1 part water. Rates of application shall be 0.10 Gal / Sq. Yd. (Diluted) or as determined by the CDOT at the time of application. Any layer of bituminous pavement that is to have a succeeding layer placed thereon shall be completed full-width before a succeeding layer is placed.

10.3.2.2 Stone Matrix Asphalt Pavement

Stone Matrix Asphalt Pavement (SMA) Acceptance shall be based on gradation.

Full-width SMA shall be utilized as the top lift of all proposed flexible pavement and on structures, deck rehabilitations, unless otherwise Approved by CDOT. SMA shall utilize PG 76-28 asphalt binder grade.

10.3.2.3 Hot Mix Asphalt Pavement

HMA mixes shall be subject to voids acceptance.

10.3.2.4 Asphalt Overlay

Locations with ruts shall be milled to a depth of ½" below the bottom of the ruts.

10.3.2.5 Asphalt Patching

Patching of permanent pavement shall be to the depth of the surrounding existing / proposed

pavement as directed by CDOT. The top lift must match the depth of the 1st lift of the proposed pavement and conform to the requirements of SMA (Fibers) (Asphalt) .Lower lifts shall conform to the requirements of HMA (Grading S) (100) (PG 64-22). The minimum and maximum lift thicknesses shall be 2 and 3 inches, respectively, for SMA (Fibers) (Asphalt) and 2.25 and 3.5 inches, respectively, for HMA (Grading S) (100) (PG 64-22). The thickness of each lift shall be less than or equal to the thickness of lift directly beneath it. All patching shall be per CDOT.

10.3.2.6 Portland Cement Concrete Pavement

Portland Cement Concrete pavement shall meet compressive strength requirements as identified in the most current CDOT Standard Specifications for Roadway and Bridge Construction. The Contractor shall be responsible for PCCP joint design. The Contractor's joint design shall include tied inside and outside shoulders. Outside mainline I-25 shoulders shall include transverse load transfer devices (DC joints). PCCP joint design shall comply with the requirements of Book 3, including but not limited to the CDOT *M & S Standard Plans*, and the 2015 CDOT M-E Pavement Design Manual~~CDOT *Pavement Design Manual*~~. The PCCP longitudinal and transverse joint designs shall be compatible with lane and shoulder configurations. The Contractor shall submit the pavement joint design to CDOT for Acceptance along with the design documents. PCCP construction shall not commence until the PCCP Jointing Plan is Accepted.

The Contractor shall tine mainline I-25 outside shoulders per CDOT standards. Station stamping is not required.

10.3.2.6 Pavement Smoothness

The Contractor shall construct the PCCP/flexible pavement for the Project to the smoothness requirements as set forth in Table 10.3.2.6.

Table 10.3.2.6
SMOOTHNESS REQUIREMENTS

Location	Pavement Smoothness Category[(ii)]
Flexible Pavement	HRI Category II (Inches/mile)
Rigid Pavement	HRI Category II (Inches/mile)
Overlay	HRI Category I (Inches/mile)
Proposed Structure	HRI Category II (Inches/mile)

10.4 Deliverables

At a minimum, the Contractor shall submit the following to CDOT for review, Approval and/or Acceptance:

Deliverables	Review, Acceptance or Approval	Schedule
Supplemental Geotechnical investigation reports	Acceptance	Within 30 Days following completion of the fieldwork
Pavement Design Report	Approval	Submitted with Design Packages
Paving Quality Control Plan	Approval	Prior to beginning paving operations
PCCP Jointing Plan	Acceptance	Submitted with Design Packages
PCCP Mix designs	Approval	At the Pre-paving Conference and at least 30 Days prior to the use of any PCCP on the Project
SMA & HMA mix designs	Approval	At the Pre-Paving Conference and at a minimum of 30 days prior to the planned placement of any HMA on the Project
RAP Quality Control Plan	Approval	Prior to beginning of paving operations
Pavement marking plan	Approval	Prior to beginning of paving operations
Detour Paving Design	Acceptance	At the Pre-paving Conference and at least 14 Days prior to the use of any Detour Pavement on the Project

All deliverables shall also conform to the requirements of Book 2, Section 3 – Quality Management.

10.5 Project Special Provisions

The following specifications modify and take precedence over the Standard Specifications.

10.5.1 Removal of Asphalt Mat (Planing)

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 202.09, and replace it with the following:

202.09 Removal of Asphalt Mat (Planing). Prior to beginning planing operations, the Contractor shall submit a planing plan and a Quality Control Plan (QCP) for approval by the Engineer. The planing plan shall include at a minimum:

(1) The number, types and sizes of planers to be used.
(2) The width and location of each planing pass.
(3) The number and types of brooms to be used and their locations with respect to the planers.
(4) The proposed method for planing and wedging around existing structures such as manholes, valve boxes, and inlets.
(5) The longitudinal and transverse typical sections for tie-ins at the end of the day.
(6) If requested by the Engineer, a plan sheet showing the milling passes.

The QCP shall include as a minimum:

(1) The schedule for replacing the cutting teeth.
(2) The daily preventive maintenance schedule and checklist.
(3) Proposed use of automatic grade controls.
(4) The surface testing schedule for smoothness.
(5) The process for filling distressed areas.
(6) The schedule for testing macrotexture of the milled surface.
(7) Corrective procedures if the milled surface does not meet the minimum macrotexture specification.
(8) Corrective procedures if the milled surface does not meet the minimum transverse or longitudinal surface finish when measured with a 10 foot straightedge.

The Contractor shall not start the planing operation until the hot mix asphalt (HMA) mix design has been approved and a Form 43 has been signed by the Engineer.

The existing pavement shall be milled to the cross-slope as shown on the plans, and shall have a surface finish that does not vary longitudinally or transversely more than 3/8 inch from a 10 foot straightedge. A 10 foot straightedge shall be supplied by the Contractor.

All milled surfaces shall be broomed with a pick-up broom, unless otherwise specified, before being opened to traffic. A sufficient number of brooms shall be used immediately after planing to remove all milled material remaining in the roadway.
If the Contractor fails to adequately clean the roadway, work shall cease until the Engineer has approved the Contractor's revised written proposal to adequately clean the roadway.

The milled surface shall have a macrotexture equal to or less than 0.170 inches for single-lift overlays and 0.215 inches for multiple-lift overlays as tested in accordance with CP 77. Milled surfaces that do not meet these criteria shall require corrective action in accordance with the QCP. The Contractor shall be responsible for testing the macrotexture of the milled surface at the location directed by the Engineer in accordance with CP 77 at a stratified random frequency of one test per 10,000 square yards or a minimum of once per work day.

At the completion of each day's work, longitudinal vertical edges greater than 1 inch shall be tapered. No transverse vertical edges will be allowed. Longitudinal milled surface tie-ins to existing pavement shall be tapered to not less than a 3:1 slope, transverse milled surface tie-ins to existing pavement shall be tapered to not less than a 50:1 slope. Transverse tapered joints may be tapered with the planing machine, a temporary asphalt ramp, or other methods approved by the Engineer. No longitudinal joint between the milled and existing surfaces shall fall between 1 to 5 feet of any lane line.

If the transverse joint is tapered with a temporary asphalt ramp, the milled surface at the joint shall be constructed as a butt joint the full depth of the lift of asphalt to be placed on the milled surface. The Contractor shall be responsible for maintaining this asphalt ramp until all corresponding HMA is placed. All work associated with this joint will not be paid for separately, but shall be included in the cost of planing.

If the transverse joint is tapered with a planing machine, a butt joint shall be cut into the taper the full depth of the lift of asphalt to be placed on the milled surface prior to commencement of resurfacing. All work associated with this joint will not be paid for separately, but shall be included in the cost of planing.

Other approved transverse joint tapers shall be maintained at the expense of the Contractor, and at a minimum shall incorporate a butt joint the full depth of the lift of asphalt to be placed on the milled surface prior to commencement of resurfacing.

Distressed or irregular areas identified in the planed surface by the Engineer shall be patched.

The roadway shall be left in a safe and usable condition at the end of each work day. The Contractor shall take appropriate measures to ensure that the milled surface does not trap or hold water. All required pavement markings removed by the planing shall be restored before the roadway is opened to traffic.
All milled surfaces to be overlaid with HMA shall be covered with new asphalt within 7 working days. All areas on this project that are not overlaid within the specified working days will be assessed a lane rental fee of $500 per occurrence for each day or fraction thereof and any required surface repairs shall be paid for by the Contractor.

All planing shall be completed full width and parallel to the travel lanes before resurfacing commences unless otherwise directed by the Engineer.

All material generated by the planing operation shall become the property of the Contractor unless otherwise noted in the Contract.

Add subsection 202.091 immediately following subsection 202.09 as follows:

202.091 Equipment

Each planer shall conform to the following:

The planer shall have sufficient power, traction and stability to maintain an accurate depth of cut. The propulsion and guidance system of the planer shall be maintained in such condition that the planer may be operated to straight and true lines.

The planer shall be capable of operating with automatic grade controls (contact or non-contact) on both sides of the machine using a 30 foot averaging system or other approved grade control systems. The use of such controls shall be described in the Contractor's QCP.

The planer shall be capable of picking up the removed material in a single operation. A self-loading conveyor shall be an integral part of the planer. Windrows will not be allowed.

Subsection 202.12 shall include the following:

Macrotexture testing, macrotexture corrective actions, planers, brooms and all other work necessary to complete the item will not be measured and paid for separately, but shall be included in the work.

10.5.2 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 shall be required on this Project. If the Contractor can demonstrate to CDOT that all of the manufacturer's recommendations were followed and the pneumatic tire roller is detrimental to the finished surface of the HMA, the Contractor may request CDOT to waive the pneumatic tire roller requirement. Pneumatic 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.

10.5.3 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 HMA is mandatory.

10.5.4 Aggregate Base Course Class 6

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 ABC Class 6 as shown in Subsection 703.03.

The ABC Class 6 must meet the gradation requirements and have a resistance value of at least 78 when tested by the Hveem Stabilometer method. Test result documentation for ABC Class 6 used for this project must be provided prior to use on site.

10.5.5 Aggregate Base Course Class 6 Special

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

Subsection 304.02 shall include the following:

Recycled Asphalt Pavement (RAP), the product of rotomill tailings or crushed asphalt pavement, utilized as ABC Class 6 (Special), shall be of uniform quality. The RAP shall meet the gradation requirements for ABC Class 6. The material shall not contain clay balls, vegetable matter, or other deleterious substances. RAP is not required to meet the requirements of Subsection 703.03.

Subsection 304.04 shall include the following:

The maximum density of RAP shall be determined in accordance with AASHTO T-180, Method A. The field moisture determination for correction to dry density shall be determined by oven or microwave drying. Moisture determination of RAP using a nuclear gauge will not be permitted.

10.5.6 Hot Mix Asphalt

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 HMA shall conform to the following:

Table 403-1

Property	Test Method	Value For Grading			
		S (100)			Patching
Air Voids, percent at: N (initial) [for information only] N (design)	CPL 5115	 3.5 – 4.5			 3.5 – 4.5
Lab Compaction (Revolutions): N (initial) [for information only] N (design)	CPL 5115	 8 100			 8 100
Stability, minimum	CPL 5106	30			30
Aggregate Retained on the 4.75 mm (No. 4) Sieve with at least 2 Mechanically Induced fractured faces, % minimum	CP 45	70			70

Table 403-1

Property	Test Method	Value For Grading			
Accelerated Moisture Susceptibility Tensile Strength Ratio (Lottman), minimum	CPL 5109 Method B	80			80
Minimum Dry Split Tensile Strength, kPa (psi)	CPL 5109 Method B	205 (30)			205 (30)
Grade of Asphalt Cement, Top Layer					PG 76-28
Grade of Asphalt Cement, Layers below Top		PG 64-22			PG 64-22
Voids in the Mineral Aggregate (VMA) % minimum	CP 48	See Table 403-2			See Table 403-2
Voids Filled with Asphalt (VFA), %	AI MS-2	65-75			65-75
Dust to Asphalt Ratio Fine Gradation Coarse Gradation	CP 50	 0.6 – 1.2 0.8 – 1.6			 0.6 – 1.2 0.8 – 1.6

Notes:
- AI MS-2 = Asphalt Institute Manual Series 2.
- The current version of CPL 5115 is available from CDOT.
- Mixes with gradations having less than 40% passing the 4.75 mm (No. 4) sieve shall be approached with caution because of constructability problems.
- 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. 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*, mm (inches)	***Design Air Voids **		
	3.5%	**4.0%**	**4.5%**
37.5 (1½)	11.6	11.7	11.8
25.0 (1)	12.6	12.7	12.8
19.0 (¾)	13.6	13.7	13.8
12.5 (½)	14.6	14.7	14.8
9.5 (⅜)	15.6	15.7	15.8

* The Nominal Maximum 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.

As a part of the Contractor's Quality Management Plan, the Contractor shall outline the steps taken to minimize segregation of HMA. The Quality Management Plan shall define a process by which the Contractor shall address unacceptable segregation, but, at a minimum, the paving shall stop and the cause of segregation shall be corrected before paving operations will be allowed to resume.

HMA for patching shall conform to the gradation requirements for SMA for the top lift and HMA (Grading S) (100) (PG 64-22) for intermediate and lower lifts. All patching determinations shall be the responsibility of the Contractor with consultation with CDOT.

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

Subsection 403.03 shall include the following:

If liquid anti-stripping additive is added at the plant, an approved in-line blender must be used. The blender shall be in the line from the storage tank to the drier drum or pugmill. The blender shall apply sufficient mixing action to thoroughly mix the asphalt cement and anti-stripping additive.

The Contractor shall construct the Work such that all roadway pavement placed prior to the time paving operations end for the year, shall be completed to the full thickness required by the plans. The Contractor's progress schedule shall show the methods to be used to comply with this requirement.

10.5.7 Stone Matrix Asphalt Pavement

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.

Stone Matrix Asphalt Pavement shall be placed and compacted in accordance with the temperatures listed in subsection 401.07 as revised for this Project.

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 according to CP 51

Subsection 401.22 shall include the following:

Acceptance, testing, and pay factors for SMA shall be in accordance with subsections 105.05 and 106.05 as revised for this Project for HMA. 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 either the SuperPave (CPL 5115, 100 Gyrations) or the Marshall Method (AASHTO T245, 50 Blow).

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 Temperature	AASHTO T305	0.3 maximum
% 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.

The Marshall SMA mix design shall conform to the following:

Mix Properties	Value
Stability, Marshall Compactor	1400 lbs., min
% Voids in Total Mix	3 – 4%
VMA (% Voids in the Mineral Aggregate)	17 min.
Lottman, CPL 5109, Method B	70% min
Dry Tensile Strength, (CPL 5109)	30 psi, min.

Regardless of mix design method, 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:

If a Superpave SMA mix design is used, 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

If a Marshall SMA mix design is used, the Contractor shall perform the following tests and provide the results to the Engineer during production:

Marshall Mix Property	Frequency
Draindown (AASHTO T 305)	1/1000 tons or fraction thereof
Stability (Marshall)	1/1000 tons or fraction thereof
Percent Voids in the total mix	1/1000 tons or fraction thereof
VMA (Percent Voids in the Mineral Aggregate)	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.

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, gradation, and Marshall Stability, if required) 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.

10.5.8 Detour

Section 621 is hereby added to the Standard Specifications for this Project and shall include the following:

621.01 This work consists of constructing detours as shown in the plans for all phases of construction on I-25, US 24 and all applicable ramps; maintenance of the detours; removal of the detours; and removal and replacement of appurtenances required to construct and operate the detours including but not limited to guardrail, curb and gutter, detour pavement, embankment material and unclassified excavations.

621.02 All materials required for detour shall comply with project standard specifications and special provisions.

The Contractor shall be responsible for quality control required to assure adequate quality of embankment material, aggregate base course, HMA used in the construction of the detour.

621.03 The detour locations and dimensions for all phases of construction shall be as shown on the plans.

If the materials and thickness furnished for the detour pavement result in an inadequate detour structure, the Contractor will provide additional thickness, materials, or other measures necessary to provide a satisfactory pavement for the life of the detour. These additional improvements shall be furnished at no additional cost. All necessary signs, pavement markings and other traffic control devices shall be provided in accordance with the traffic control plan.

621.04 The Contractor shall maintain the detour for the entire period that it is open to traffic. Any distress that affects the ride, safety, or serviceability of the detour roadway shall be corrected to the satisfaction of the CDOT at the expense of the Contractor.

The Contractor shall have a maintenance plan for all hours of the day (7 days a week) for executing a long term patch of damaged detour pavement, and have forces available to perform this work within 2 hours of notice of such damage. The Contractor shall designate a person to be “on call” during all non-working hours, including no work periods as a point of contact for this work.

If CDOT determines the detour has deteriorated to the point where the safety of the traveling public is compromised (i.e. potholes), the lane(s) in question shall be closed and the Contractor shall be directed to execute their maintenance plan. If the Contractor is unresponsive to this order by CDOT, CDOT maintenance forces will be mobilized to close the lane and maintain the closure until such time as the Contractor is available to perform this work. CDOT Maintenance forces will be responsible for the lane closure only, and only until such time as the Contractor arrives on site and relieves them. CDOT Maintenance will not be responsible for repair of any of the contract installed detour. All time and expense for CDOT Maintenance work will be tracked by CDOT and deducted from money due to the Contractor. Any lane closures that are required outside of the allowable lane closure hours will be charged as 'working time violation' as established in this contract.