10.0 GEOTECHNICAL AND ROADWAY PAVEMENTS

10.1 General

10.1.1. Geotechnical Investigations

Geotechnical investigations performed by the Colorado Department of Transportation (CDOT) are provided in Book 3.

The Contractor shall be responsible for any supplemental subsurface investigation necessary to complete the Work. Geotechnical investigations and analysis shall comply with the requirements of the 2017 CDOT *Field Materials Manual* (2017 CDOT *FMM*), the CDOT *2017 M-E Pavement Design Manual AASHTO Load Resistance Factor Design (LRFD) Bridge Design Specifications, Seventh Edition*, where applicable, the most current Union Pacific Railroad (UPRR)-Burlington Northern Santa Fe (BNSF) *Guidelines for Railroad Grade Separation Projects*, the American Railway Engineering and Maintenance-of-Way Association (AREMA) *Manual for Railway Engineering*, and any other applicable standards necessary to perform the Work. The roadway pavement sampling shall conform to the recommendations in the Region Soil Sampling Checklist presented in Chapter 200 of the 2017 CDOT *FMM*. 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 or analysis work within areas of contaminated soil or groundwater. Alternative Technical Concepts (ATC) and Pavement Designs provided by the Contractor shall not cause re-analysis of the Life-Cycle Cost Analysis (LCCA) without concurrence from CDOT as being necessary. Required modifications to the approved pavement design ATCs as a result of conditions identified by the supplemental subsurface investigations performed by the Contractor shall be the sole responsibility of the Contractor.

Table 10-1 Geotechnical Boring Depth and Minimum Frequency Table

Exploration Type		Recommended Minimum Number of Borings	Recommended Minimum Boring Depth
Foundations	Drilled Shaft	One per substructure unit < 100 feet width Two per substructure unit > 100 feet width	10 feet into bedrock (N ≥ 50) or 3D below tip elevation.
	Driven Piles		10 feet into bedrock (N ≥ 50) or 20 feet 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	One at each end and every 100 feet along axis	3H or 10 feet into bedrock (N ≥ 50)
Walls	Mechanically Stabilized Earth (MSE)/Cast in Place	One at each end and every 200 feet along wall	2H or 10 feet into bedrock (N ≥ 50)
	Tieback Anchor	One in anchorage zone spaced every 200 feet along wall	
	Soil Nail/Ground Nail	One in nail zone 1H from wall every 200 feet along wall	

Exploration Type		Recommended Minimum Number of Borings	Recommended Minimum Boring Depth
Landslide		Three along center of slide. Place at least one boring above and below sliding area.	10 feet 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			20 feet.
Material Soil Survey	Pavement realignment or widening	One every 1,000 feet along centerline or determined by Materials Engineer.	Minimum of 5 feet below top of proposed pavement elevation or determined by Materials Engineer.
	Cut sections – road widening	One at each end of cut section and every 500 feet or determined by Materials Engineer.	
	Cut sections – new alignment	One at each end of cut section on opposite shoulders. If cut > 20 feet vertical, 1 boring through deepest section of cut on centerline.	
	Embankment Fill > 20 feet New alignment	One at centerline of deepest fill area.	

Modified from *Checklists and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications.* Publication No. FHWA ED-88-05, Table 2; 2017 CDOT *FMM, Chapter 200, AASHTO LRFD Bridge Design Specifications, 4th Edition,* Table 10.4.2.1; and *Landslides: Investigation and Mitigation, 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 Design 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 and meet CDOT *2017 M-E Pavement Design Manual* distress thresholds. The top layer of the Surface Course resists skidding, traffic abrasion, and the disintegrating effects of climate, traffic, and the environment.

To provide for adequate sulfate resistance, all concrete supplied to the project shall be designed for Class 2, Severity of Sulfate Exposure unless field testing indicates a greater sulfate resistance is required. The Contractor may, at their expense, have a certified laboratory test the subgrade as per the 2017 CDOT *FMM*. 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 unless field testing indicates a greater sulfate resistance is required.

10.2.2. Roadway Pavement Analysis and Design

CDOT has performed the baseline pavement design and LCCA to determine the pavement types, thicknesses of bases and sub-bases, and sub-grade requirements that shall be used on this Project. This treatment selection shall be utilized as the basis for Contractor ATCs utilizing the same design parameters and the same calibration factors.

The Contractor shall be responsible for the final pavement design using Version 2.2, Build 2.2.6 of the AASHTOWare Pavement M-E Design software (M-E Design software) for all pavement constructed as part of this project. Contractor designs shall utilize the Colorado-specific calibration model and shall follow the inputs, calibration factors, material properties, etc. set forth in the pavement design report as referenced in Exhibit 10-A. The material properties of the pavement, base, sub-base, and subgrade used during construction shall follow those used in the CDOT *2017 M-E Pavement Design Manual* and CDOT baseline pavement design. Level 2 Design Parameters or Level 1 Design Parameters, when better information is available, shall be used. Level 3 Design Parameters will not be applicable or used without specific written concurrence of their applicability from CDOT. Items in conflict between the CDOT *2017 M-E Pavement Design Manual* and CDOT baseline design shall follow inputs outlined in the CDOT baseline design. Hot mix asphalt (HMA) and concrete mixes from CDOT's material databases shall be used in all M-E Design analysis. Generic, nationwide, or similar, samples of HMA and concrete shall not be utilized in the analysis without prior written Approval by CDOT as applicable for use and design within CDOT Roadways. The Contractor shall explicitly delineate any differences between the CDOT baseline pavement design and the ATC pavement design model proposed by the Contractor. All pages of the M-E Design Output Report proposed by the Contractor shall be provided to CDOT. The exact model (electronic file) which generated the associated design shall also be provided to CDOT for review. A narrative detailing the changes from the CDOT baseline model and associated detailed description and justification of changes and/or assumptions shall be provided with every ATC pavement design for review. Review and any associated review and comment times will not begin until all Requests for Information (RFI), narratives, and assumptions/descriptions are received from the Contractor. It is the Contractor's responsibility to furnish this information in a timely manner. CDOT is not responsible for any delays associated with furnishing incomplete information to CDOT for ATC pavement designs.

Rigid pavement designs, consisting of Portland Cement Concrete Pavement (PCCP), shall contain load transfer devices and tied inside and outside shoulders and doweled outside shoulders. PCCP shall be designed for a 30-year design life for new pavement and pavement structure and shall meet a minimum of a 30-year design life for rehabilitated pavement.

Flexible pavement designs consist of 3 inches of Stone Matrix Asphalt (SMA) (Fibers) (Asphalt) with HMA (Grading S) (100) (PG 64-22) utilized for all lower lifts of the pavement in order to match the existing adjacent asphalt thickness. Asphalt pavement shall be used for tie-ins to existing flexible pavement. Flexible pavement designs shall be designed for a 20-year design life for new pavement and pavement structure and shall meet a minimum of a 20-year design life for rehabilitated pavement. Binder PG grading shall be determined as identified in LTPPBind 3.1 available from http://www.fhwa.dot.gov/pavement/ltpp/ltppbind.cfm.

The pavement shall be Uniform for all of the segments identified. For pavement construction, Uniform shall be defined as:

1. Pavement material thickness and subgrade treatment shall be consistent for the linear and transverse section limits defined in Table 10-4.
2. Consistent subgrade drainage shall be provided laterally to a location at least 2 feet beyond the edge of pavement to an enclosed water conveyance system or daylight to an open gravity flow

ditch. The Contractor is responsible for managing and mitigating subsurface drainage per Book 2, Section 12.

3. Existing Edge drains must be preserved to continue to be functional or modified to provide positive drainage to daylight drainage.
4. Vertical sag areas in alignments shall have transverse drains installed under the pavement to daylight. Drains shall be located at the lowest point of the sag and shall be sufficient in size to drain the area.

All pavement shall be constructed full width, including inside and outside shoulders. Location descriptions, Pavement Type, Pavement Thickness, Base and Sub-base Strengths and Thickness, and Subgrade requirements for Project Roadways are shown in Table 10-5 through Table 10-8.

Continuously reinforced PCCP will not be permitted.

Precast concrete panels will not be allowed for the permanent pavement surface.

Recycled PCCP will not be allowed in the new pavement.

The Contractor shall be responsible for designing, providing, and maintaining detour pavements in a safe and serviceable condition, subject to CDOT Acceptance. The Contractor shall determine the type and thickness of detour pavement through the use of M-E Design and shall submit a Detour Pavement Design to CDOT for Acceptance in accordance with the CDOT *2017 M-E Pavement Design Manual* and CDOT baseline design parameters. Detour Pavement design shall be submitted to CDOT a minimum of 14 Days prior to detour paving for Acceptance. The detour thickness design shall be based on the actual subgrade strength and traffic loading for the length of time the detour is anticipated to be in service or a minimum 2-year design life in M-E Design, whichever is greater. If the Contractor's Detour Pavement Design requires thicknesses greater than the minimum to serve for the life of the detour pavement, these shall be provided at no additional cost.

The Contractor shall anticipate that there is not sufficient structure within the inside and outside shoulders to accommodate traffic.

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

The Contractor shall construct the trail concrete pavement to the thickness requirements for the Project, as set forth in the Table 10-2.

Table 10-2 Trail Pavement Design Parameters

Location	Required Trail Pavement Section Thickness (inches)		
	Concrete (Special)*	Aggregate Base Course (Class 6)	Embankment
All project Trails	5 inches	4 inches	12 inches R-20 minimum. See Book 2, Section 11 and Section 13

*Refer to Book 2, Section 13, Exhibit 13-B, Poudre River Trail Design Criteria.

10.2.4. Park-n-Ride

The Contractor shall construct the Parking Lot facilities as set forth in Table 10-3.

Table 10-3 Parking Lot Pavement Design Parameters

Location	Required Pavement Section Thickness (inches)		
	Material	Aggregate Base Course (Class 6)	Embankment
Driveway at Kendall Parkway	11 inches PCCP	6 inches	24 inches R-40
Driveway at SH 402	6 inches HMA	6 inches	24 inches R-40
Bus parking and loading area	11 inches PCCP	6 inches	24 inches R-40
Parking lot	6 inches HMA	6 inches	24 inches R-40

10.2.5. Existing Pavement Sections

Where existing pavement is to be overlaid and existing joints do not coincide in location with new pavement joints, the existing pavement shall be sawcut in a manner to align with joints of the new pavement.

Where existing pavement is to be overlaid, the inside and outside shoulders shall be removed to a point where there is consistent thickness with the existing lanes, so as to provide a uniform thickness to meet project design. Additionally, the shoulders shall be removed full depth to a point where they will align with successive layers and lane lines.

When Port of Entry Weigh In Motion (WIM) platform pavement is to be overlaid, the new pavement shall be flush with existing scale cells, or the scale cells shall be removed and reset, or replaced, to be flush with the new pavement surface. The new pavement shall not interfere with the operation of existing loop detectors. Where new pavement does interfere with the operation of existing loop detectors, new detectors shall be installed and connected to the existing WIM communication system.

10.2.6. Alternate Pavement Designs

Pavement Designs shall be for the full lengths of each segment provided in Table 10-5 . ATCs for partial segments will not be allowed.

All materials being proposed to be incorporated into the roadway prism must be able to be represented within the M-E Design software for Acceptance. Alternative material's performance is required to be verified through documented resources as to the materials structural value within the roadway prism and with formal guidance on how it should be modeled within the CDOT M-E Design software. The Contractor is required to provide the documentation and formal guidance of incorporation of material into the M-E Design software. Insufficient documentation and/or lack of adequate modeling of a material's structural value may be cause for decline of pavement modifications.

Calibration factors used in Alternative Pavement Designs shall be the same as the Baseline CDOT design and presented in Exhibit 10-A. Modifications of calibration factors shall not be allowed.

HMA and PCCP mixes from CDOT's material databases shall be used in all M-E Design analysis. Generic, nationwide, or similar samples of HMA and PCCP shall not be utilized in the analysis without prior Approval by CDOT as applicable for use and design within CDOT Roadways.

All material being modeled within the M-E Design software for ATC pavement designs shall be representative of actual materials that will be installed. Deviation of modeling procedures in ATC pavement designs from to-be-installed materials will only be allowed with CDOT's Approval.

The Contractor shall use the design parameters listed in Table 10-4.

Table 10-4 Minimum M-E Design Parameters

Parameters	Input	
	Mainline	Ramps
Reliability	95%	95%
Two Way average annual daily truck traffic (AADTT)	9,000/10,000	1,000/2,000
Number of Lanes in Design Direction	2	1
Percent of Trucks in Design Direction	50	100
Percent of Trucks in Design Lane	90	100
Operational speed (in miles per hour [mph])	75 mph	35 mph
Vehicle Class Distribution (CDOT)	Cluster 2	Cluster 2
Growth rate %	2.6	2.6
Growth function	Compound	Compound
Climate station	Fort Collins, CO	Fort Collins, CO
Depth of Water Table	10	10
Condition of Existing Flexible Pavement (AC Layer Properties)	Rehabilitation Level: 2 (Existing Distress to be included)	Rehabilitation Level: 2 (Existing Distress to be included)
Design life (Rigid)(New Construction)	30 year Minimum	30 year Minimum
Design Life (Rigid)(JPCP over AC)	30 year Minimum	30 year Minimum
Design life (Flexible)(New Construction)	20 Year Minimum	20 Year Minimum
Design Life (Flexible) (AC over AC)	20 Year Minimum	20 Year Minimum
Performance criteria thresholds	Per CDOT *2017 M-E Pavement Design Manual*	
Gradation of Rubblization for modeling in ME	A-1-a	A-1-a
Resilient Modulus of Rubblization for Modeling in ME (pounds per square inch, psi.)	32,883 psi.	32,883 psi.

All M-E designs shall use 12 foot design lane width. Modification of the design lane width will require appropriate modification of the traffic wander deviation and supporting justification for the modification. All PCCP designs shall be based on a 15 foot joint spacing.

Existing distress of pavements are available through the Pavement Management System on a 10th mile basis and at Contractor's specific request. This information shall be used in the determination of Condition of Existing Flexible Pavement parameters noted above. Pavement Management System data collected in 2016 shall be used in this analysis. Information obtained from Pavement Management System data is For Information Only and use, liability of use, and analysis of this information is the responsibility of the Contractor. Analysis shall be performed by Contractor and evaluated by CDOT for

appropriateness of use in ATC pavement designs. This information and its analysis shall be provided to CDOT at time of ATC pavement design submission.

Falling Weight Deflectometer (FWD) data for Interstate 25 (I-25) has been collected for the Project. This information is available For Information Only. FWD data shall not be used as a substitute design method in lieu of Pavement M-E Design. Analysis of FWD data shall be analyzed using software compatible with EVERCALC. It is the Contractor's responsibility to perform any and all analysis of the FWD data, if the Contractor elects to use this data. Reduction of CDOT baseline pavement design sections will not be allowed below the minimum pavement thickness, base thickness and/or strength, sub-base thickness and/or strength, and subgrade thickness and/or strength values presented in the CDOT baseline pavement design without an Approved ATC. Any and all liability of use associated with the use, analysis, and interpretation of FWD data, if elected to be used for the ATC process, is the responsibility of the Contractor.

Use of chemical stabilization techniques for ATC pavement designs is specifically disallowed. Chemical Stabilization of bases, sub-bases, and subgrades are not allowed on this Project.

10.2.7. Non-CDOT Roadways Pavement Designs

CDOT *2017 M-E Pavement Design Manual* or approved local agency design procedures.

10.2.8. Structure Foundation Analysis and Design

Structure foundation analysis and design shall follow requirements per Book 2, Section 15.

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 Accepted 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 CDOT.

Tack coats for asphalt products shall be utilized in accordance with the following:

- Tack coat (Diluted) for asphalt products on this project shall be one part emulsified asphalt (slow setting) and one part water. The rate of application shall be 0.1 gallons per square yard.
- A tack coat of emulsified asphalt (slow setting) is to be applied to improve bond at the following locations:
  - Before placing new pavement over existing pavement
  - Along the face of all curbs, gutters, manholes, adjacent existing pavement, and other surfaces against which asphalt will be placed
  - Between pavement courses

10.3.1. Roadway Pavement Construction Requirements

A minimum of 30 Days prior to the proposed construction of any pavement on the Project, a Pre-paving Conference shall be conducted. Prior to the Pre-paving Conference, the Contractor shall present mix designs for SMA, HMA, and PCCP to CDOT for Approval.

10.3.2. Roadway Pavement Types and Thickness Requirements

10.3.2.1 Portland Cement Concrete Pavement

PCCP shall meet flexural strength requirements as identified in the most current CDOT *Standard Specifications for Road and Bridge Construction* and any currently approved *Standard Special Provisions* as detailed in Book 2, Section 20.

The Contractor shall texture I-25 shoulders and ramps in a manner consistent with that of mainline I-25. Station stamping is not required.

Partially reconstructed ramps shall match the thickness of the existing ramp pavement.

The following Minimum Pavement Design Parameters (Table 10-5) shall be followed based upon the baseline CDOT *2017 M-E Pavement Design Manual* for PCCP where full reconstruction of the pavement section is required.

Table 10-5 Minimum Pavement Design Parameters for PCCP (Full Reconstruction)

Mainline I-25 Location	Pavement Type	Design Life (Years)	2020 Daily Truck Volume (AADTT)	Thickness of PCCP (in.)	Thickness of ABC Class 6 (in.)	Thickness of R-40 Embankment (in.)
MP 265.3 to MP 267.5 Harmony Road to Port of Entry	Rigid	30	9,000	13.5	6	24
MP 262.3 to MP 265.3 SH 392 to Harmony Road	Rigid	30	9,000	13.5	6	24
MP 259.3 to 262.3 Crossroads Blvd. to SH 392	Rigid	30	10,000	14.0	6	24
MP 257.3 to MP 259.3 US 34 to Crossroads Blvd.	Rigid	30	10,000	14.0	6	24
MP 254.6 to MP 257.3 SH 402 to US 34	Rigid	30	10,000	14.0	6	24

Baseline PCCP designs based on use of 1.75 inch diameter dowel bars. ABC = CDOT Class 6 Aggregate Base Course.

The following Minimum Pavement Design Parameters (Table 10-6) shall be followed based upon the baseline CDOT *2017 M-E Pavement Design Manual* for PCCP where overlay of existing pavement sections is feasible.

Table 10-6 Minimum Pavement Design Parameters for PCCP (Overlay)

Mainline I-25 Location	Pavement Type	Design Life (Years)	2020 Daily Truck Volume (AADTT)	Thickness of PCCP (in.)	Remaining Existing HMA (in.)	Thickness of Rubblized Concrete (in.)
MP 265.3 to MP 267.5 Harmony Road to Port of Entry	Rigid	30	9,000	13.5	4	8
MP 262.3 to MP 265.3 SH 392 to Harmony Road	Rigid	30	9,000	13.5	4	8
MP 259.3 to 262.3 Crossroads Blvd. to SH 392	Rigid	30	10,000	13.5	4	8
MP 257.3 to MP 259.3 US 34 to Crossroads Blvd.	Rigid	30	10,000	13.5	4	8
MP 254.6 to MP 257.3 SH 402 to US 34	Rigid	30	10,000	13.5	4	8

Baseline PCCP designs based on use of 1.75 inch diameter dowel bars. Remaining HMA thickness is based on a minimum of 7 inches of HMA prior to milling at least the top 3 inches prior to overlay.

In the overlay sections of pavement, the inside and outside shoulders shall be removed to a point where there is consistent thickness with the existing lanes, so as to provide a uniform thickness to meet project design. Additionally, the shoulders shall be removed full depth to a point where they will align with successive layers and lane lines.

10.3.2.2 Stone Matrix Asphalt on Hot Mix Asphalt Pavement

The following Minimum Pavement Design Parameters (Table 10-7) shall be followed based upon the baseline M-E Design software for SMA on HMA where full reconstruction of the pavement section is required.

Table 10-7 Minimum Pavement Design Parameters for SMA on HMA (Full Reconstruction)

Mainline I-25 Location	Pavement Type	Design Life (Years)	2020 Daily Truck Volume (AADTT)	Thickness of SMA on HMA (in.)	Thickness of ABC Class 6 (in.)	Thickness of R-40 Embankment (in.)
MP 265.3 to MP 267.5 Harmony Road to Port of Entry	Flexible	20	9,000	3 SMA 10 HMA	6	24
MP 262.3 to MP 265.3 SH 392 to Harmony Road	Flexible	20	9,000	3 SMA 10 HMA	6	24
MP 259.3 to 262.3 Crossroads Blvd. to SH 392	Flexible	20	10,000	3 SMA 10 HMA	6	24
MP 257.3 to MP 259.3 US 34 to Crossroads Blvd.	Flexible	20	10,000	3 SMA 10 HMA	6	24
MP 254.6 to MP 257.3 SH 402 to US 34	Flexible	20	10,000	3 SMA 10 HMA	6	24

The following Minimum Pavement Design Parameters (Table 10-8) shall be followed based upon the baseline M-E Design software for SMA on HMA where overlay of existing pavement sections is feasible.

Table 10-8 Minimum Pavement Design Parameters for SMA on HMA (Overlay)

Mainline I-25 Location	Pavement Type	Design Life (Years)	2020 Daily Truck Volume (AADTT)	Thickness of SMA on HMA (in.)	Remaining Existing HMA (in.)	Thickness of Rubblized Concrete (in.)
MP 265.3 to MP 267.5 Harmony Road to Port of Entry	Flexible	20	9,000	3 SMA 4 HMA	4	8
MP 262.3 to MP 265.3 SH 392 to Harmony Road	Flexible	20	9,000	3 SMA 4 HMA	4	8
MP 259.3 to 262.3 Crossroads Blvd. to SH 392	Flexible	20	10,000	3 SMA 4 HMA	4	8
MP 257.3 to MP 259.3 US 34 to Crossroads Blvd.	Flexible	20	10,000	3 SMA 4 HMA	4	8
MP 254.6 to MP 257.3 SH 402 to US 34	Flexible	20	10,000	3 SMA 4 HMA	4	8

Remaining HMA thickness is based on a minimum of 7 inches of HMA prior to milling at least the top 3 inches prior to overlay.

In the overlay sections of pavement, the inside and outside shoulders shall be removed to a point where there is consistent thickness with the existing lanes, so as to provide a uniform thickness to meet project design. Additionally, the shoulders shall be removed full depth to a point where they will align with successive layers and lane lines.

10.3.2.3 Pavement Smoothness

The Contractor shall construct the PCCP flexible pavement for the Project to the smoothness requirements as set forth in Table 10-9.

Table 10-9 Smoothness Requirements

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

Pavement smoothness requirements shall apply to new shoulders, rehabilitated shoulders, and ramps in addition to the mainline pavement. An incentive for pavement smoothness will not be paid.

10.4 Deliverables

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

Table 10-10 Deliverables

Deliverables	Review, Acceptance or Approval	Schedule
Supplemental Geotechnical investigation reports	Acceptance	Within 30 Days following completion of the fieldwork
Preliminary Pavement Design Report	Review	As part of the Preliminary Design Plans
Pavement Design Report	Acceptance	As Part of the Pre-RFC Review Documents and Final RFC Documents Submittals
Paving Quality Control Plan (QCP)	Approval	At the Pre-Paving Conference and at a minimum of 30 Days prior to the planned placement of any SMA/HMA/PCCP on the Project
Preliminary PCCP Jointing Plan	Review	As Part of the Preliminary Design Plans (30%) Submittal
PCCP Jointing Plan	Acceptance	As Part of the Pre-RFC Review Documents and Final RFC Documents Submittals
PCCP Jointing Plan for Connecting New to Existing Pavement	Acceptance	As Part of the Pre-RFC Review Documents and Final RFC Documents Submittals
PCCP Mix designs	Approval	Prior to the Pre-paving Conference and at least 30 Days prior to the use of any PCCP on the Project
SMA and HMA mix designs	Approval	Prior to the Pre-Paving Conference and at a minimum of 30 Days prior to the planned placement of any SMA/HMA on the Project
Preliminary Pavement Marking Plan	Review	As Part of the Preliminary Design Plans (30%) Submittal
Pavement Marking Plan	Acceptance	As Part of the Pre-RFC Review Documents and Final RFC Documents Submittals
Detour Paving Design	Acceptance	At the Pre-paving Conference
Planing Plan and QCP	Approval	At the pre-pave conference and at least 30 Days prior to beginning planing operations
QCP Outlining the Steps Taken to Minimize Segregation of HMA	Approval	At the Pre-Paving Conference and at a minimum of 30 Days prior to the planned placement of any HMA on the Project
Inlet/Manhole Modifications Plans	Acceptance	Concurrently with each applicable Traffic Control Plan (TCP)

All Jointing Plans shall be submitted on 1:50 scale plans with fully scalable and legible letters, numbers, and details.

10.5 Project Special Provisions

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

REVISION OF SECTION 202
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). At the pre-pave conference and at least 30 Days prior to beginning planing operations, the Contractor shall submit a planing plan and Quality Control Plan (QCP) for Approval by CDOT. 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.

If requested by CDOT, 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.

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 CDOT 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 CDOT 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 CDOT. 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 CDOT 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 10 Days. All areas on this project that are not overlaid within 10 Days will be assessed a lane rental fee of $5,000 per occurrence for each day or fraction thereof and any required surface repairs shall be paid for by the Contractor.

REVISION OF SECTION 304
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. Testing shall be per CP-L 3101 (Resistance R-Value and Expansion Pressure of Compacted Soils or Aggregates by Means of Hveem Stabilometer). Test result documentation for ABC Class 6 used for this project must be provided prior to use on site.

REVISION OF SECTION 401
HOT MIX ASPHALT COMPACTION

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 has demonstrated 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, CDOT, in cooperation with the Contractor and the Region Materials Engineer, may waive the pneumatic tire roller requirement. Pneumatic tire rollers shall not be used on SMA pavement. Steel wheel rollers shall not be operated in vibratory mode on bridge decks.

REVISION OF SECTIONS 401 AND 703
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. CDOT will 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 (Rapid Test) or Method C (CoreDry Test), unless the SMA mixture is being placed on a structure (bridge deck) in which case CDOT may specify that nuclear gauge measurements 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 shall be 93 to 97 percent of the SMA daily 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 Hot Mix Asphalt. 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.

REVISION OF SECTION 403
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 (design)	CPL 5115	3.5 – 4.5	3.5 – 4.5
Lab Compaction (Revolutions): N (design)	CPL 5115	100	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
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 3/4" to 3/8" are considered a coarse gradation if they pass below the maximum density line at the #8 screen.
- Gradations for mixes with a nominal maximum aggregate size of #4 or smaller are considered a coarse gradation if they pass below the maximum density line at the #16 screen.

*Fractured face requirements for SF may be waived by RME depending on project conditions.

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 percent below the mix design optimum. CDOT will establish the production asphalt cement and volumetric targets based on the Contractor's mix design and the relationships shown between the hot mix asphalt mixture volumetric properties and asphalt cement contents on the Form 429. CDOT may select a different AC content other than the one shown at optimum on the Contractor's mix design in order to establish the production targets as contained on the Form 43. Historically, Air Voids adjustments typically result in asphalt cement increases from 0.1 to 0.5 percent. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

Table 403-2

Nominal Maximum Size*, mm (inches)	**Minimum Voids in the Mineral Aggregate (VMA)**			
	*****Design Air Voids ****			
	3.5%	**4.0%**	**4.5%**	**5.0%**
37.5 (1½)	11.6	11.7	11.8	N/A
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	
4.75 (No. 4)	16.6	16.7	16.8	16.9

* 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.

The Contractors QMP shall include asteps taken to minimize segregation of HMA. This plan shall be submitted to CDOT for Approval at the Pre- Paving Conference and at a minimum of 30 Days prior to the planned placement of any HMA on the Project. When CDOT 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.

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.

CDOT approved Warm Mix Asphalt (WMA) may be allowed on this project in accordance with CP-52 and CP-59. WMA mixes shall utilize additives from the CDOT Approved Products List (APL). 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 1% hydrated lime by weight of the combined aggregate shall be added to the aggregate for all HMA.

Acceptance samples shall be taken per CP 41.

Subsection 403.03 shall include the following:

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.

Aggregate, asphalt recycling agent, asphalt cement, additives, hydrated lime, and all other work and materials necessary to complete each hot mix asphalt item will not be paid for separately, but shall be included in the unit price bid. When the pay item includes the PG binder grade, any change to the submitted mix design optimum asphalt cement content to establish production targets on the Form 43 will not be measured and paid for separately, but shall be included in the work. No additional compensation will be considered or paid for any additional asphalt cement, plant modifications and additional personnel required to produce the HMA as a result in a change to the mix design asphalt cement content.

Historically, typical asphalt cement increases reflected on the Form 43 are from 0.1 to 0.5 percent. However, the Contractor should anticipate the AC increases typical of his mixes. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

Excavation, preparation, and tack coat of areas to be patched will not be measured and paid for separately, but shall be included in the work.

REVISION OF SECTION 403
STONE MATRIX ASPHALT PAVEMENT

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 1/2 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).

A minimum of two weeks prior to the proposed use of any Stone Matrix Asphalt pavement on the project, a pre-paving conference will be conducted. At that time, the Contractor shall submit to CDOT, a mix design meeting the appropriate specification requirements for one of the following:

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 the Region Materials Engineer
Note: Copies of AASHTO R 46 and M 325 can be obtained from the Region Materials Engineer
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 percent below the mix design optimum. CDOT will establish the production asphalt cement and volumetric targets based on the Contractor's mix design and the relationships shown between the Stone Matrix Asphalt mixture volumetric properties and asphalt cement contents on the Form 429. CDOT may select a different AC content other than the one shown at optimum on the Contractor's mix design in order to establish the production targets as contained on the Form 43. Historically, Air Voids adjustments typically result in asphalt cement increases from 0.1 to 0.5 percent. Contractors

bidding the project should anticipate this change and factor it into their unit price bid.
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 percent 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 CDOT 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 CDOT 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

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. Delays to the project due to WMA submittal and review will be considered within the Contractor's control and will be non-excusable. Contractors proposing to use WMA shall supply detailed design, production and acceptance testing requirements prior to completion of the Form 43. Approved WMA submittals shall contain all of this information prior to CDOT approval. Only CDOT Approved WMA will be allowed for use on the project.

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 CDOT 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 CDOT. 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.

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. CDOT will determine the coring locations using a stratified random sampling process. The cores shall be immediately submitted to CDOT 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 CDOT observation. Coring will not be measured and paid for separately but shall be included in the work.

REVISION OF SECTION 412
PORTLAND CEMENT CONCRETE PAVEMENT

Section 412 of the Standard Specifications is hereby revised for this project as follows:

Subsection 412.13 shall include the following:

(d) *Pressure Relief Joints*. Pressure relief joints in PCCP as shown in the Book 4 drawing titled Concrete Expansion Joint Details shall be installed 1) at a minimum of one per mile increments and 2) immediately adjacent to bridge structures and installed to the requirements and included Pressure Relief Joint Standard Drawings included herein.

General: This material is a flexible, low density, multicellular homogeneous neoprene foam. It must be designed to create constant compression with the concrete joint faces once it is installed. If there is a possibility that the pavement will contract and the seal will be required to act in tension an epoxy adhesive must be used to secure the seal to the concrete joint. The joint seal is to be four inches wide and be inserted into a 3 ¾ inch joint gap. The depth and length shall be determined by the manufacturer. The product must conform to AASHTO M 220 and ASTM D 2628 when pertaining to pavement joints, or AASHTO M 297 and ASTM D 3542 if the product is intended for bridge use. Reinforcing steel shall be grade 60.

Table 10-11 Physical Requirements for Preformed Elastomeric Joint Seals

Property	Requirements	ASTM Method
Tensile Strength, min	2000 psi	D 412
Elongation at break, min	250%	D 412
Hardness Type A durometer, points	55 ± 5	D 2240 (modified)[A]
Oven aging, 70h at 212°F		D 573
Tensile Strength loss, max	20% max	
Elongation loss, max	20% max	
Hardness, Type A durometer, points change	0 to + 10	
Oil Swell ASTM Oil 3 70h at 212°F		D 471
Weight change max	45% max	
Ozone resistance		D 1149 (modified)[B]
20% strain 300 pphm in air 70h at 104°F	no cracks	
Low-temperature stiffening 7 Days at 14°F		D 2240
Hardness, Type A durometer, points change	0 to + 15	
Low-temperature recovery,[C] 72h at 14°F, 50% deflection, min	88%	D 2628
Low-temperature recovery,[C] 22h at -20°F, 50% deflection, min	83%	D 2628
High-temperature recovery,[C] 70h at 212°F, 50% deflection, min	85%	D 2628
Compression-deflection at 80% of nominal width, min	3.5 lbf/in	D 2628

[A] The term "modified" in the table relates to the specimen preparation. The use of joint seal as the specimen source requires that more plies than specified in either of the modified test procedures be used. Such specimen modification shall be agreed upon by the purchaser and seller prior to testing. The hardness test shall be made with the durometer in a durometer stand as recommended in Method D 2240
[B] Test in accordance with Procedure A of D 518
[C] Cracking, splitting, or sticking of a specimen during a recovery test shall mean that the specimen has failed the test

All epoxies, adhesives, lubricants, cementing agents, etc., that are required for installation of the seals are to be specified and provided by the manufacturer. All installation is to be in strict accordance with the specified procedures and practices of the seal manufacturer.

Properly package all of these components and provide instructions for safe handling, storage, transport, proper disposal of component and container, emergency procedures, etc. Durably label all containers

with name and address of the manufacturer, date of manufacture, shelf life or expiration date if applicable, a unique identifier such as a batch or lot number, and any other relevant information.

Openings for the joint material shall be formed or sawed. Prior to installation of the joint material the faces of the joint shall be sandblasted followed by an air blast to clean all dust and debris from the joint face. Sandblasting and air blasting shall be limited to the amount that may be sealed in the same workday. A foam spacer block may be used beneath the seal to provide additional stability, but the foam must be easily compressible, so not to interfere with the joint or the joint seal's compression. Application and installation equipment shall be provided by the manufacturer and shall be inspected to ensure that installation meets the design and manufacturer's requirements.

REVISION OF SECTION 412 RUBBLIZATION OF CONCRETE PAVEMENT

Section 412 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of rubblization and settling and seating of the existing reinforced or non-reinforced portland cement concrete pavement as shown on the plans or as directed by CDOT. The work shall be accomplished in accordance with the Standard Specifications, this special provision and the details shown on the plans.

CONSTRUCTION REQUIREMENTS

General. Rubblization of the existing portland cement concrete pavement shall be accomplished across the full depth and panel width of the pavement. The rubblization shall be done in partial widths as necessary to maintain traffic. When rubblizing in a lane adjacent to a lane that is open to traffic, measures shall be taken to prevent debris from entering the traffic lane. The Contractor shall exercise care during the rubblization operation to protect and prevent damage to underground and drainage facilities.

The Contractor shall minimize the dispersion of dust from the rubblizing operation, until the rubblized surface is overlaid with pavement, by the application of non-excessive water or other approved method.

A joint shall be cut full depth at an existing joint on ramps or mainline where rubblization abuts concrete which is to remain in place.

Equipment. Rubblization of the portland cement concrete pavement shall be accomplished with either a Resonate breaker or a Multi-Head breaker. The breaking unit shall be capable of delivering such energy as may be necessary to satisfactorily break the pavement. The breaker shall be equipped with a screen to protect vehicles in the adjacent lane from flying chips during the fracturing process when necessary.

Resonate Breaker Method.

(a) Pavement Breaker. Breaking of the concrete pavement shall be accomplished with a self-contained, self-propelled, resonant frequency pavement breaking unit capable of producing low-amplitude 2,000 pound force blows at a rate not less than 44 cycles per second.

(b) Steel Roller. A smooth drum steel vibratory roller having a gross weight of not less than 10 tons, operated in vibratory mode, shall be used to settle and seat the rubblized pavement.

Multi-Head Breaker Method.

(a) Pavement Breaker. Breaking of the concrete pavement shall be accomplished with a self-contained, self-propelled, unit with hammers mounted laterally in pairs with half the hammers in a forward row and the remainder diagonally offset in a rear row so that there is continuous breakage from side to side. The lift height of the hammers shall be independently adjustable. The equipment shall have the capability of rubblizing a 13 foot lane in a single pass.

(b) Steel Roller. A steel vibratory roller fitted with a "Z" pattern grid on the drum face having a gross weight of not less than 10 tons, operated in vibratory mode, shall be used to settle and seat the rubblized pavement.

(c) Pneumatic roller: A pneumatic roller having a gross weight of not less than 25 tons shall be used to settle and seat the rubblized pavement.

All other equipment required for rubblization shall have been approved by CDOT prior to start of rubblization operations.

Rubblization. Rubblization shall begin at a free edge or previously broken edge and progress toward the opposite shoulder or longitudinal centerline of the road. In areas where the roadway must be overlaid one lane at a time, initial rubblization shall extend a minimum of 6 inches beyond the width of the pavement to be overlaid.

The existing concrete pavement shall be broken into particles mostly ranging from sand size to six inches. 75% of the particles by weight in the top three inches of the rubblized layer shall be two inches or less in any one dimension. No individual piece shall exceed nine inches in any dimension. Any pieces of rubblized concrete greater than nine inches shall be removed or reduced to an acceptable size and the resulting void replaced with ABC Class 6 at the Contractor's expense.

At the beginning of the rubblization operations, a 4-foot by 4-foot test section shall be excavated from the edge to the middle of a lane at a location selected by CDOT to determine if the breaker is producing pieces of the specified sizes. Additional test sections may be required if CDOT determines that they are necessary. The test section material shall be removed from the project and the hole shall be filled using Hot Mix Asphalt (Patching) (Asphalt).

The Contractor shall continuously monitor the rubblization operation and shall make adjustments in the striking pattern, striking energy, number of passes or other factors as necessary to continually achieve acceptable breaking throughout the project.

The breaker shall be operated to avoid damaging the base and underlying structures. If damage occurs to the base or underlying structures, the contractor shall repair any damage at his expense.

Reinforcement in the rubblized pavement, if any, shall be left in place. However, any reinforcement exposed at the surface during rubblization or compacting operations shall be cut off below the surface and removed. In addition, any loose joint filler, crack sealant, expansion material, or other similar items shall also be removed.

If unstable areas occur due to expansion of the existing pavement, these areas will be removed to a maximum length of 4 feet in length and 12 feet in width and replaced full depth with Hot Mix Asphalt (Patching)(Asphalt). Patching of unstable areas and test section holes shall conform to the requirements of Section 403.

Settling and Seating. The rubblized pavement shall be settled and seated in the following sequence or as approved by CDOT. For this operation, a pass is defined as forward and back over the entire rubbilized surface area. CDOT may require additional passes if necessary to satisfactorily settle and seat the rubblized pavement.

Resonate Breaker Method.

Following the rubblization, a steel drum vibratory roller shall be used for a minimum of three passes. The roller shall be operated at a speed not to exceed 6 feet per second.

Multi-Head Breaker Method.

Following the rubblization, a steel drum vibratory roller fitted with a "Z" pattern grid on the roller face shall be used for two passes. This shall be followed by one pass with a pneumatic roller. Immediately prior to overlaying, one additional pass shall be made with the vibratory roller. The rollers shall be operated at a speed not to exceed 6 feet per second.

REVISION OF SECTION 412
THIN WHITETOPPING

Section 412 of the Standard Specifications is hereby revised for this project as follows:

Subsection 412.10 shall include the following.

(a) *Surface Milling.* If HMA is needed on the project to prepare the surface for PCCP, the HMA shall be milled to a minimal depth in order to roughen the surface texture.
(b) *Surface Cleaning*. Cleaning of the surface shall be accomplished by sweeping the surface using a pickup mechanical broom. The surface shall be further cleaned by the use of pressure cleaning with air or water to ensure all dust, grit, and foreign material is removed from the surface. The area shall be protected as necessary to prevent contamination until concrete placement. When areas are not adequately protected, the Contractor shall perform additional cleaning prior to placement of concrete overlay as directed.
(c) *Surface Preparation.* After the surface has been milled, cleaned, and accepted, a moisture coat shall be placed on the prepared surface. The Contractor shall spray a light mist of water in a manner that does not cause excessive ponding. The concrete overlay shall be placed while the surface is still wet.
(d) *Surface Temperature.* Concrete pavement shall not be placed when the surface temperature of the HMA is 120° F or greater.

The concrete pavement overlay shall be placed to the depth specified in the Contract. If milling is performed by the Contractor at locations not specified in the Contract, the Contractor shall supply a detailed milling plan that insures a minimum HMA depth of 4 inches after milling and the data shall be approved by CDOT prior to placing concrete pavement.

REVISION OF SECTION 412
TIE BAR INSPECTION

Section 412 of the Standard Specifications is hereby revised for this project as follows:

Subsection 412.13(b) 1 shall include the following:

If tie bars are inserted into plastic concrete with a tie bar insertion machine, tie bar location and concrete consolidation shall be subject to the following additional requirements:

Each 2500 linear feet of longitudinal weakened plane joint resulting from the procedure shall have one random location cored where the core intercepts an inserted tie bar. The core shall be six-inch diameter taken in the presence of the Engineer.

If non-consolidated concrete is evident above the inserted tie bar, the Contractor shall cease paving operations and submit a corrective action plan in writing for approval. Correction of the joint and further paving shall take place only after written approval of the corrective action plan has been provided by CDOT. Additional coring may be required, as directed by CDOT.

Further failure to consolidate the concrete over the tie-bars will be justification to preclude the use of automatic tie-bar insertion for the remainder of the project.

REVISION OF SECTION 603

REINFORCED CONCRETE PIPE

Section 603 of the Standard Specifications is hereby revised for this project as follows:

Subsection 603.02 shall include the following:

Reinforced concrete pipe shall be manufactured from concrete that meets the requirements for severity of sulfate exposure Class 2 specified in subsection 601.04.

Reinforced concrete pipe shall be coated in accordance with subsection 706.07 if PH of soil or water is less than 5.

REVISION OF SECTION 621
DETOUR PAVEMENT

Detour Pavement shall also conform to the requirements of Book 2, Section 16, Transportation Management Plan.

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

This work consists of design and construction of detour pavement as shown in the plans for all phases of construction on I-25, all applicable ramps, and all affected roadways requiring detour pavement; 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.

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, PCCP, and HMA used in the construction of the detour.

Areas showing high spots of more than 3/8 inch in 10 feet shall be reworked during placement or marked and diamond ground if discovered after placement until the high spot does not exceed 3/8 inch in 10 feet.

Where detour traffic will run over existing or new drainage inlets or manholes, the inlets or manholes shall be modified by the Contractor to provide a level riding surface. Inlet grates and manhole covers shall be securely fastened to the inlet using methods and materials capable of resisting cyclical vehicular and dynamic impact loads. Grate/cover conditions shall be checked by the Contractor daily, and shall be re-fastened immediately if found to be loose, or repaired if damaged. Plans for inlet or manhole modifications shall be signed and sealed by the Contractors Engineer and shall be submitted to CDOT for Acceptance concurrently with each applicable Traffic Control Plan (TCP). When detour traffic will no longer run over the modified inlets or manholes, the inlets or manholes will be modified as necessary to meet the permanent design configuration. All modification work and materials to accommodate detour conditions and subsequent modifications for permanent conditions, shall be included in the cost of Detour Paving, and will not be paid for separately.

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

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.

10.6 Addendum to the Field Materials Manual

The following Field Materials Colorado Procedure(s) modify and take precedence over the 2017 CDOT *FMM*.

Colorado Procedure 12C-17

Standard Practice for

Contractor's Excavation and Embankment Process Control Notebook

1. SCOPE

1.1. This Standard describes the best practice to be used when developing appropriate worksheets and forms in a PC notebook.

1.2. The requirements such as, but not limited to: the sample size, specimen size, number of specimens, interpretation of results, reporting significant digits, and precision statements are in the specific test method.

2. GENERAL PC NOTEBOOK REQUIREMENTS

2.1. The following information shall be included on each page of a worksheet or form:

(1) Project number, Contract ID, and Project location
(2) Name of the laboratory performing the test
(3) Date, location, and time the sample was taken or the beginning of the test
(4) Name of the person taking the sample, performing the test, and certifications
(5) Test number
(6) Type of test performed
(7) Remarks area

3. SAMPLE LOCATION WORKSHEET

3.1. The following shall be included on the sample location worksheet:

(1) Stationing, elevation, lift thickness, and lift number placed
(2) Sampling method (core, grab, auger, shovel, in place, etc.)

4. SITE PREPARATION WORKSHEET

4.1. When preparing the site for embankment, the following shall be included in the worksheet:

(1) Clearing and grubbing conducted in accordance with Specification 201.
(2) Thickness of top soil removed by Station interval.
(3) Type, thickness, and volume of unsuitable materials removed.
(4) Area and depth of material plowed or scarified
(5) Depth of excavation below subgrade elevation in bedrock areas
(6) Description of foundation materials below embankment fill (include AASHTO soil classification) by Station interval
(7) Compaction methods used to prepare embankment foundation by Station interval
(8) Moisture content, dry density, and percent relative compaction of foundation materials where applicable.
(9) Existing slope of embankment foundation area by Station interval
(10) Bench key depth where required
(11) Number of benches and depth of each bench as embankment is constructed to grade
(12) Volume of bench excavation used in embankment
(13) Trouble area location, type (swampy ground, springs, etc.), and mitigation

5. EMBANKMENT PLACEMENT AND COMPACTION WORKSHEET

5.1. When placing and compacting embankment material the following shall be included on the worksheet:

(1) Site conditions (standing water, weather, temperature, etc.)
(2) Material processing performed prior to placement to meet material requirements specified
(3) Material placement method (end dump, side dump, belly dump, cast, etc.)

(4) Structure type adjacent to embankment
(5) Embankment Material Classification and results to verify classification
(6) Changes in material types and corresponding changes in construction methods
(7) Lift number and loose lift thickness
(8) Spreading equipment used
(9) Moisture conditioning and compaction methods and equipment used
(10) Methods to document or test compaction, and results of observations or tests conducted. Description of defective work and corrective action taken.
(11) Location and elevation of fill placement by Station interval and volume placed daily.
(12)
(13) Daily summary of all tests conducted and results.

5.2. When placing and compacting Soil Embankment, the following shall be included on the worksheet:

(1) Classification and corresponding compaction and testing methods used
(2) Processing methods to achieve maximum particle size
(3) Changes in material type and corresponding changes to construction and testing methods
(4) Processing methods for Non-durable bedrock and placement location
(5) Results of moisture-density testing, proof rolls, and documentation of test strip acceptance where applicable
(6) Condition and performance of each lift of material placed and compacted

5.3. When placing and compacting Rock Embankment and Rock Fill, the following shall be included on the worksheet:

(1) Processing methods to achieve material requirements in accordance with Specification 203
(2) Documentation of sampling for and results of slake durability testing
(3) Contractor moisture conditioning, placement and compaction methods
(4) Results of proof rolls, documentation of test strip acceptance
(5) Changes in material type and corresponding changes to construction and testing methods
(6) Description of compaction equipment and methods used, and documentation of deviations from minimum equipment requirements specified if applicable
(7) Condition and performance of each lift of material placed and compacted

6. TEST STRIP OR PROOF ROLL

6.1. When constructing a test strip or conducting a proof roll, the following shall be included on the worksheet:

(1) Moisture conditioning, compaction equipment, and compaction methods used to construct the test strip
(2) Equipment used in proof roll
(3) Axle load and weight ticket
(4) Lift thickness and lift number
(5) Results of proof roll pass/fail
(6) Observation of deflection, rutting, or pumping and corrective action taken.
(7) Start and end time

Was test strip or proof roll separate or incorporated into embankment.

10.7 Exhibits

Exhibit 10-A Colorado Specific M-E Pavement Design Calibration Factors, 2017

Exhibit 10-A Colorado Specific M-E Pavement Design Calibration Factors, 2017

Table 10-A1 New PCCP Calibration Factors

Distress Criteria	Calibration Factor
PCC Cracking	
PCC Cracking C1	2
PCC Cracking C2	1.22
PCC Cracking C4	0.6
PCC Cracking C5	-2.05
PCC Reliability Cracking Standard Deviation	Pow(57.08*CRACK,0.33) + 1.5
PCC Faulting	
PCC Faulting C1	0.51040
PCC Faulting C2	0.00838
PCC Faulting C3	0.00147
PCC Faulting C4	0.008345
PCC Faulting C5	5999
PCC Faulting C6	0.8404
PCC Faulting C7	5.92930
PCC Faulting C8	400
PCC Reliability Faulting Standard Deviation	0.0831*Pow(FAULT,0.3426) + 0.00521
PCC IRI-CRCP	
PCC IRI C1	3.15
PCC IRI C2	28.35
PCC IRI Initial CRCP Std. Dev.	5.4
PCC IRI-JPCP	
PCC IRI J1	0.8203
PCC IRI J2	0.44170
PCC IRI J3	1.49290
PCC IRI J4	25.240
PCC IRI Initial JPCP Std. Dev.	5.4
PCC Longitudinal Cracking	
PCC Longitudinal Cracking C4	0
PCC Longitudinal Cracking C5	0
PCC Reliability Longitudinal Cracking Std. Dev.	
PCC Punchout	
PCC CRCP C1	2
PCC CRCP C2	1.22
PCC CRCP C3	107.73
PCC CRCP C4	2.475

Distress Criteria	Calibration Factor
PCC CRCP C5	-0.785
PCC CRCP Crack	1
PCC Reliability PO Standard Deviation	2.208 * Pow(PO,0.5316)

Table 10-A2 New AC Calibration Factors

Distress Criteria	Calibration Factor
AC Cracking	
AC Cracking Bottom Standard Deviation	1 + 15/(1+exp(-3.1472-4.1349*LOG10(BOTTOM+0.0001)))
AC Cracking C1 Bottom	0.021
AC Cracking C1 Top	7
AC Cracking C2 Bottom	2.35
AC Cracking C2 Top	3.5
AC Cracking C3 Bottom	6000
AC Cracking C3 Top	0
AC Cracking C4 Top	1000
AC Cracking Top Standard Deviation	200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))
AC Fatigue	
AC Fatigue BF1	130.3674
AC Fatigue BF2	1
AC Fatigue BF3	1.21779
AC Fatigue K1	0.007566
AC Fatigue K2	3.94920
AC Fatigue K3	1.2810
AC Rutting	
AC Rutting BR1 (1)	4.3
AC Rutting BR2 (1)	1
AC Rutting BR3 (1)	1
AC Rutting K1 (1)	-3.35412
AC Rutting K2 (1)	1.5606
AC Rutting k3 (1)	0.3791
AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001
IRI	
IRI Flexible C1	50
IRI Flexible C2	0.55
IRI Flexible C3	0.0111
IRI Flexible C4	0.02
IRI Flexible Over PCCC1	40.80

Distress Criteria	Calibration Factor
IRI Flexible Over PCCC2	0.5750
IRI Flexible Over PCCC3	0.0014
IRI Flexible Over PCCC4	0.00825
Subgrade Rutting	
Fine Subgrade Rutting BS1	0.37
Fine Subgrade Rutting K1	1.35
Fine Subgrade Rutting Standard Deviation	0.0663 * Pow(SUBRUT,0.5) + 0.001
Granular Subgrade Rutting BS1	0.22
Granular Subgrade Rutting K1	2.030
Granular Subgrade Rutting Standard Deviation	0.0104 * Pow(BASERUT,0.67) + 0.001
Thermal Fracture	
AC Thermal Cracking Level 1K	6.3
AC Thermal Cracking Level 1 Std. Dev.	0.1468 * THERMAL + 65.027
AC Thermal Cracking Level 2K	0.5
AC Thermal Cracking level 2 Std. Dev.	0.2841 * THERMAL + 55.462
AC Thermal Cracking Level 3K	6.3
AC Thermal Cracking Level 3 Std. Dev.	0.3972 * THERMAL + 20.422
CSM Cracking	
CSM Cracking C1	0
CSM Cracking C2	75
CSM Cracking C3	5
CSM Cracking C4	3
CSM Standard Deviation	CTB*1

Table 10-A3 AC over AC Rehabilitation Calibration Factors

Distress Criteria	Calibration Factor
AC Cracking	
AC Cracking Bottom Standard Deviation	1.13 + 13/(1+exp(7.57-15.5*LOG10(BOTTOM+0.0001)))
AC Cracking C1 Bottom	1
AC Cracking C1 Top	7
AC Cracking C2 Bottom	1
AC Cracking C2 Top	3.5
AC Cracking C3 Bottom	6000
AC Cracking C3 Top	0
AC Cracking C4 Top	1000
AC Cracking Top Standard Deviation	200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))

Distress Criteria	Calibration Factor
AC Fatigue	
AC Fatigue BF1	130.3674
AC Fatigue BF2	1
AC Fatigue BF3	1.217799
AC Fatigue K1	0.007566
AC Fatigue K2	3.9492
AC Fatigue K3	1.281
AC Rutting	
AC Rutting BR1 (1)	4.3
AC Rutting BR2 (1)	1
AC Rutting BR3 (1)	1
AC Rutting K1 (1)	-3.35412
AC Rutting K2 (1)	1.5606
AC Rutting k3 (1)	0.3791
AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001
IRI	
IRI Flexible C1	50
IRI Flexible C2	0.55
IRI Flexible C3	0.0111
IRI Flexible C4	0.02
IRI Flexible Over PCCC1	40.80
IRI Flexible Over PCCC2	0.5750
IRI Flexible Over PCCC3	0.0014
IRI Flexible Over PCCC4	0.00825
Reflective Fatigue Cracking AC	
Reflective Fatigue Cracking AC C1	0.38
Reflective Fatigue Cracking AC C2	1.66
Reflective Fatigue Cracking AC C3	2.72
Reflective Fatigue Cracking AC C4	105.4
Reflective Fatigue Cracking AC C5	-7.020
Reflective Fatigue Cracking AC K1	0.012
Reflective Fatigue Cracking AC K2	0.005
Reflective Fatigue Cracking AC K3	1
Reflective Fatigue Cracking AC Std. Dev.	1.1097 * Pow(FATIGUE,0.6804) + 1.23
Reflective Transverse Cracking AC	
Reflective Transverse Cracking AC C1	3.22
Reflective Transverse Cracking AC C2	25.7
Reflective Transverse Cracking AC C3	0.1
Reflective Transverse Cracking AC C4	133.4

Distress Criteria	Calibration Factor
Reflective Transverse Cracking AC C5	-72.4
Reflective Transverse Cracking AC K1	0.012
Reflective Transverse Cracking AC K2	0.005
Reflective Transverse Cracking AC K3	1
Reflective Transverse Cracking AC Std. Dev.	70.98 * Pow(TRANSVERSE,0.2994) + 30.12
Subgrade Rutting	
Fine Subgrade Rutting BS1	0.37
Fine Subgrade Rutting K1	1.35
Fine Subgrade Rutting Standard Deviation	0.0663 * Pow(SUBRUT,0.5) + 0.001
Granular Subgrade Rutting BS1	0.22
Granular Subgrade Rutting K1	2.030
Granular Subgrade Rutting Standard Deviation	0.0104 * Pow(BASERUT,0.67) + 0.001
Thermal Fracture	
AC Thermal Cracking Level 1K	1.5
AC Thermal Cracking Level 2K	0.5
AC Thermal Cracking Level 3K	1.5