

## 10.0 GEOTECHNICAL AND ROADWAY PAVEMENTS

This section includes the requirements for the geotechnical and Roadway pavements work for the Design Build Project (Project). This work shall be completed in accordance with the Contract Documents

### 10.1 Administrative Requirements

#### 10.1.1 Standards

The Contractor shall design and construct the Project in accordance with the requirements of the standards in the documents listed in Table 10-1 and those referenced in Book 3. The Contractor shall use the latest adopted edition at the time of the Proposal Due Date.

**Table 10-1. Standards**

Author or Agency	Title
American Association of State Highway and Transportation	<i>AASHTOWare Pavement Mechanistic-Empirical Design Software, Version 2.3.1</i>
AASHTO	<i>Load Resistance Factor Design (LRFD) Bridge Design Specifications</i>
AASHTO	<i>Policy on Geometric Design of Highways and Streets</i>
Colorado Department of Transportation (CDOT)	<i>Standard Specifications for Road and Bridge Construction (Standard Specifications)</i>
CDOT	<i>Mechanistic-Empirical (M-E) Pavement Design Manual</i>
CDOT	<i>Field Materials Manual</i>
CDOT	<i>Bridge Design Manual</i>
CDOT	<i>Geotechnical Design Manual</i>
CDOT	<i>M&amp;S Standard Plans</i>

### 10.2 Geotechnical Investigations

The results of geotechnical investigations performed by CDOT are provided in Book 5 - 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 CDOT Field Materials Manual, the M E CDOT Pavement Design Manual 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 within 30 days following completion of the fieldwork. The reports shall be signed and sealed by a Professional Engineer and must be Accepted by CDOT prior to Release for Construction drawings.

If groundwater observation wells are necessary to monitor water level or water quality, it shall

be the Contractor’s responsibility to properly abandon, permit, or renew the permits of these wells in accordance with Colorado State Engineer’s Office (CSEO) requirements.

The minimum depth and frequency of geotechnical borings for subsurface explorations is provided in Table 10-2. Roadway subgrade sampling is required for all pavement areas and shall conform to the *Region Soil Survey Sampling Checklist for Soil Survey of Constructed Roadbeds* presented in Chapter 200 and CP 24-19 of the CDOT *Field Materials Manual*. The soil survey shall be completed prior to beginning construction of the pavement Subbase course, in accordance with Book 2, Section 11.

**Table 10-2 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		3H or 10 feet into bedrock (N ≥ 50).
Wall	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	
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 CDOT.	Minimum of 5 feet below top of proposed pavement elevation or determined by CDOT.
	Cut sections – road widening	One at each end of cut section and every 500 feet or determined by CDOT.	
	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 > 5 feet New alignment	One every 500 feet with at least one through the greatest thickness of fill.	Borings shall extend at least 2 times the total height of the proposed fill below the base elevation or 5 feet into hard substratum (N>30).

Modified from *Checklists and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications*. Publication No. Federal Highway Administration (FHWA) ED-88-05, Table 2; CDOT *M-E Pavement Design Manual*, Chapter 4; CDOT *Field Materials Manual*, Chapter 200; AASHTO *LRFD Bridge Design Specifications*, Table 10.4.2-1.

D = Diameter    B = Footing Width    H = Wall Height    L = Footing Length    N = Blow count values in 12

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inches

## 10.3 Design Requirements

### 10.3.1 Submittals

All submittals shall be prepared, Reviewed, and submitted in accordance with the requirements set forth in Book 2, Section 3.

### 10.3.2 Sulfate Resistant Concrete

Concrete for foundation elements and pavements shall be designed for Class 2 Severity of Sulfate Exposure unless field sampling and laboratory testing indicates a greater sulfate resistance is required. The Contractor may, at their expense, have a certified laboratory test the subgrade as per the 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.

### 10.3.3 Structure Foundation Analysis and Design

Structure foundation analysis and design shall follow the requirements provided in Book 2, Section 15. Subsurface conditions the existing structure locations have been evaluated by CDOT and are documented in the Preliminary Geotechnical Studies (PGS). Foundation designs for structures may require supplemental geotechnical investigations. Performance and reporting of supplemental geotechnical investigations shall be in accordance with Section 10.2. Foundation analysis and design for Structures shall conform to the AASHTO LRFD Bridge Design Specifications and the CDOT Bridge Design Manual.

Preliminary Foundation Design Reports shall be submitted for Review for each major Structure and minor Structure as required in Book 2, Section 15, for the design of foundations for Bridges, retaining walls, and other Structures. The report shall be in draft form and contain design recommendations and substantiating analysis for foundation elements, lateral earth load parameters, soil corrosivity analysis, seismic design parameters, and any other geotechnical design or analysis parameters necessary to complete the design. The Preliminary Foundation Report shall be submitted to CDOT for Review with the Preliminary Design Plans package.

The Foundation Design Reports shall be revised from the Preliminary Foundation Design Report and be the basis for the load analysis from seismic and earth loads and the basis for the design of foundation elements. Supplemental soil borings required for Structures design shall have been completed.

Foundation Design Reports shall be submitted to CDOT for Acceptance 30 Days following completion of supplemental field Work or with the Release for Construction (RFC) Documents per Book 2, Section 3.

### 10.3.4 Baseline Roadway Pavement Analysis and Design

#### 10.3.4.1 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:

1. *Subbase*. The layer or layers of specified or selected material placed on a subgrade to support a base course, surface course, or both.
2. *Base Course*. The layer or layers of specified or selected material placed on a subbase or a subgrade to support a surface course.
3. *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.

#### 10.3.4.2 Baseline Pavement Design

CDOT has performed the baseline pavement design and Pavement Justification Report(s) 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 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.

#### 10.3.5 Detours

The Contractor shall be responsible for designing, providing, and maintaining detour pavements in a safe and serviceable condition, subject to CDOT Approval. The Contractor shall determine the type and thickness of detour pavement through the use of M-E Design software and shall submit a detour pavement design to CDOT for Approval a minimum of 14 Days prior to detour paving. Detour pavements shall be designed in accordance with the CDOT *M-E Pavement Design Manual* and CDOT baseline design parameters. The minimum 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. Where detours will include existing paved Shoulders, the Contractor shall verify that there is sufficient Pavement Structure within the Shoulders to accommodate detour traffic.

#### 10.4 Construction Requirements

Excavation to the profile grades shown on the Reference Drawings, and possible alternative profile grades proposed by the Contractor, may expose transitions in Subgrade Materials. The Contractor shall perform subsurface exploration at Subgrade transition areas to confirm and document thickness of suitable native Subgrade and adequate depth of sub excavation for placement of Subbase Materials.

The Contractor shall construct the Pavement Structure in accordance with the requirements of the Contract Documents.

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 Acceptance and construction Paving Quality Control Plans (QCP) for HMA to CDOT for Approval. If the Hot Mix Asphalt will contain Recycled Asphalt Pavement (RAP), a RAP Quality Control Plan shall be submitted at that time as well.

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.

The Contractor shall be responsible for constructing a Safety Edge in accordance with the requirements of the Contract Documents.

Any existing item which is to remain and is damaged as a result of the Contractor’s operation, shall be replaced at the Contractor’s expense.

**10.4.1 HMA Pavement Construction**

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

Location	Required Pavement Section Thickness (inches)			Pavement Smoothness Category
	HMA	Aggregate Base Course (Class 6)	Embankment	
US 350	6”	6”	See Section 11	II
US 24	6”	6”	See Section 11	II
CO 9	6”	6”	See Section 11	II
CO 239	6”	6”	See Section 11	II
US 350, US 24, CO 9, and CO 239 Overlay Transitions	1.5”		-	II

The Contractor shall use HMA Grading SX(75)(PG 58-28) for the HMA pavement and comply with the requirements in this Section and the specifications in Section 19 – Modifications to Standard Specifications and Section 20 – Project Special Provisions. HMA mixes shall be subject to AC/Gradation acceptance criteria.

Hot Mix Asphalt shall be constructed in lifts as follows:

Top layer: One, 1 1/2-inch layer of HMA (Grading SX)(75)(PG 58-28)

Bottom Layers: One, 2 1/2-inch layer and one, 2-inch layer of HMA (Grading SX)(75) (PG 58-28)

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

1. 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.

2. A tack coat of emulsified asphalt (slow setting) is to be applied to improve bond at the following locations:
  - A. Before placing new pavement over existing pavement.
  - B. Along adjacent existing pavement, and other surfaces against which asphalt will be placed.
  - C. Between new pavement courses.

The Contractor shall use HMA (Grading SX) for HMA patching and comply with the specifications in Section 20.

The Contractor shall prepare a Quality Control Plan (QCP) outlining the steps taken to minimize segregation of HMA. This plan shall be submitted to CDOT at the pre-paving conference.

The Contractor shall submit a pavement joint plan and pavement striping plan to CDOT for review and Approval prior to beginning paving operations. Paving shall not occur until these documents have been Approved.

#### **10.4.2 Hot Mix Asphalt Overlays**

The Contractor shall remove 1.5 inches of existing asphalt by planing prior to placing 1.5 inches of HMA for the overlay transitions and tie-in locations. HMA overlays shall be full-width. Overlay transitions to and from structures and all other tie-in locations shall have a thickness taper of 1 inch per 100 feet. Locations with ruts shall be milled to a depth of ½” below the bottom of the ruts. All milled surfaces shall be covered with new HMA within 5 working days.

#### **10.4.3 Smoothness**

Pavement Smoothness Criteria shall be MRI Category II.

#### **10.4.4 Shouldering**

Shouldering Material is required. The shouldering Materials and placement shall conform to the requirements of Project Special Provision – Revision of Sections 304 and 703 Aggregate Base Course (Shouldering Material).

### **10.5 Deliverables**

At a minimum, the Contractor shall submit the following to CDOT for review, Approval or

Acceptance:

Deliverable	Review, Acceptance or Approval	Schedule
Geotechnical investigation reports	Acceptance	Prior to Release for Construction drawings
Supplemental Geotechnical Investigation Reports	Acceptance	To CDOT within 30 Days following completion of field work
Preliminary Foundation Design Reports	Review	As part of the Preliminary Design Plans submittal
Foundation Design Reports	Acceptance	30 Days following completion of supplemental field Work or as part of the Pre-RFC Documents submittals
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
Detour Paving Design	Approval	14 Days prior to beginning detour construction
Paving Quality Control Plan	Approval	At the Pre-Paving Conference and at a minimum of 3 weeks prior to the planned placement of any HMA on the Project
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.
RAP Quality Control Plan	Approval	At the Pre-Paving Conference and at a minimum of 30 Days prior to the planned placement of any HMA on the Project
Pavement joint plan	Approval	Prior to beginning paving operations
Pavement marking plan	Approval	Prior to beginning paving operations
Concrete mix designs	Approval	30 Days prior to concrete placement

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