

CHAPTER 23 – STREET INSPECTION AND TESTING PROCEDURES

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CHAPTER 23 – STREET INSPECTION AND TESTING PROCEDURES

23.1 GENERAL REQUIREMENTS

23.1.1 Quality Assurance

A. Inspection.

A Local Entity Engineer shall observe key steps of the construction process, including permit processing, key inspections, overall compliance with these Standards, and the approved plan set and acceptance procedures. Key inspection times will occur in the following phases: right-of-way grading, trenching for utilities, structures, non-structural concrete, pavement and traffic signs, striping and signals. Adequate construction inspections are also the basis for acceptance by the Local Entity.

Upon completion of the construction work, and prior to Local Entity's acceptance of work and issuance of Certificate of Occupancy, copies of the "Record Drawings," all required test reports, and the Designer's statement that the roads and appurtenances have been constructed in conformance with the approved lines, grades, specifications, and Standards shall be delivered to the Local Entity Engineer before a request for collateral release will be considered.

B. Qualifications for Local Entity Engineer and Tester.

All inspection and testing personnel shall be certified at the NICET Level II or above or appropriate Lab Cat level for work performed. Equivalent training and/or experience may be accepted by the Local Entity in lieu of the NICET Certification. All concrete field testers are required to have Level I, ACI field certification. Documentation of all qualifications for Local Entity Engineer and testers shall be submitted at the construction coordination meeting.

C. Testing.

During the construction process the Developer is required to provide testing from an independent laboratory on all infrastructure installation including soils, concrete, asphalt, and other applicable tests as described in **Table 23-1** of this chapter.

All testing laboratories engaged in testing for projects shall be pre-qualified by the Local Entity.

D. Developer Responsibility.

These Standards state the minimum requirements for materials sampling, testing, and inspection. All tests shall be made and certified by an approved independent testing laboratory. The Developer shall be responsible for retaining a licensed Geotechnical Engineer for material testing. All costs required and pertaining to testing, the work performed, and materials supplied to verify compliance with these Standards shall be the responsibility of the Developer. All retesting shall be at the Developer's expense.

Where certified test reports are required to be furnished by the manufacturer, the Developer shall furnish duplicate copies of the reports to the Local Entity Engineer before the material will be approved for use. The test data shall be delivered to Local Entity within 48 hours of the testing.

The use of the Geotechnical Engineer's services does not relieve the Developer of the responsibility to furnish the required materials and to perform the required construction in full compliance with these Standards. Passing test results do not constitute acceptance of the work or materials represented by the test. The Developer is responsible for quality control of their work.

In various sections of these Standards, specific testing or other data is required by the Local Entity to insure that the intent of these Standards is fulfilled. The costs of such tests or other specific data where required by these Standards or on the approved plans shall be borne by the Developer. When evidence indicates that the work performed may not comply with these standards or the approved plan, the Local Entity Engineer may require additional tests or data beyond that required in these Standards or on the approved plans. The costs of such tests shall be borne by the Developer. Should such tests or additional data show a failure to meet these Standards or the approved plans, the Developer shall be responsible for all costs associated with repair or replacement of said failure.

The costs of all inspections and oversight of the construction process shall be paid for by the Developer. Refer to **Section 23.8** for requirements and fees.

E. Use of Non-Approved Material.

In the event any material or equipment proposed to be used by the Developer is disapproved by the Local Entity Engineer as not meeting the requirements of these Standards, said materials or equipment shall not be used on the Project. If, after approval of the Plans, the Developer desires to change any materials or equipment from that previously approved by the Local Entity Engineer, said change shall be accomplished only by a written request to the Local Entity Engineer. The Local Entity Engineer must approve any change before any materials can be ordered.

All materials used on the project shall be approved by the Local Entity. The Developer shall submit the proper documentation and receive approval or denial from the Local Entity within 45 days.

F. Pavement Design Report.

The pavement design report required in these Standards shall be submitted and approved a minimum of 5 working days prior to any paving. Refer to **Chapter 10, Pavement Design and Technical Criteria**.

G. Geotechnical Engineer Access and Assistance.

The Developer shall allow the Geotechnical Engineer access to the job site at all times. The Developer shall furnish any labor required to assist the Geotechnical Engineer in obtaining and handling samples at the source of material and at the

Project. The Developer shall provide and maintain, for the sole use of the Geotechnical Engineer, adequate facilities for safe storage and proper curing of concrete test specimens on the Project site as required by **AASHTO T23**.

The Geotechnical Engineer personnel are not authorized to stop work, to revoke, alter, relax, enlarge, or release any requirements of the Standards, nor to approve, accept, or reject any portion of the Work on behalf of the Local Entity.

H. Mix Designs.

The Developer shall furnish to the Local Entity Local Entity Engineer pavement mix designs meeting the requirements of these Standards a minimum of 5 working days prior to intended use of the mix. The mix design shall be reviewed and accepted by the Local Entity Engineer prior to use. If a mix design not accepted by the Local Entity is used, the Local Entity may require removal of all improvements placed with the unaccepted material.

I. Test Reports.

Test reports submitted to the Local Entity shall include all tests performed on the project. Reports shall be reviewed by a Professional Engineer competent in the required testing practice. All test reports shall show the location where the test was performed or at which the work or batch represented by the test. Test reports shall include all information specified in the **AASHTO**, ASTM, or Colorado test procedure used. Improperly completed reports will not be accepted.

Prior to acceptance of each phase of a project, all final reports signed and sealed by a Professional Engineer shall be submitted to the Local Entity indicating compliance with these specifications.

J. Warranty Period.

The warranty period for the completed public street improvements cannot start until all required test reports, record drawings, inspection reports, and other documentation are submitted in the proper format and accepted by the Local Entity.

23.1.2 Quality Assurance Testing and Reporting

All testing methods and procedures performed by the Geotechnical Engineer personnel shall be done in accordance with the applicable **AASHTO**, ASTM, or Colorado Procedure requirements and procedures (see **Table 23-1**). Test reports shall include the **AASHTO**, ASTM, and Colorado Procedures (CP) test designations of all tests taken. All testing and retesting services shall be done at the expense of the Developer.

When changes in materials or proportions are encountered during construction, or when the work fails to pass tests or fails to meet the Standards, additional tests shall be taken as directed by the Local Entity Engineer. Failure of the Developer to furnish satisfactory test data shall be sufficient cause for rejection of the work in question.

Chapter 23 – STREET INSPECTION AND TESTING PROCEDURES
Section 23.1 General Requirements

**Table 23-1
Material Testing**

Soils	AASHTO	ASTM	Frequency
Sampling	T87	D420	
Soil Classification	M145	D3282 D2488/D2487	Per soil type encountered
Moisture-Density (Proctor)			Per soil type encountered
Standard	T99	D698	As specified in Geotechnical Report
Modified	T180	D1557	As specified in Geotechnical Report
Density and Moisture Content	T238 & T239	D2922 & D3017	"Right of Way"
-Grading			1/1000 cubic yards
-Embankment			1/500 lf/lane (min. of 1 per street) 1' vertical
-Subgrade			1/500 lf/lane (min. of 1 per street)
-Utility Trench			
-Main			1/100 lf horizontal & per 1.5' vertical
-Services			2 per service (vertical)
-Manhole/Fire Hydrants			1/2' vertical within 2' alternating directions (min. of 4)
Hot Mix Asphalt (HMA)			
Sampling	T168	D979	
Density			
-Nuclear	----	D2950	1/500 lane feet (min. of 1 per street) per lift
-Coring	T166	D2726	As required or directed
-Laboratory Theoretical	T209	D2041	As required or directed
Asphalt Content & Gradation		D5444 or C136 (Gradation)	1/500 tons
Solvent	T164	D2172	
Ignition Oven	T308	D6307	
Nuclear	T287	D4125	
Thickness		D3549	As required or directed
Aggregate Gradation	T27	D5444 or C136	As required or directed
Fractured Faces		D5821	As required or directed
Concrete			
Sampling	T141	C172	
Mold and Cure	T23	C31	
Transportation of Cylinders	T23	C31	
Physical Properties			1/75 cubic yards/One per day Min.
Slump	T119	C143	Refer to 23.4.1.1; 23.5.3.C and Table 23-2
Air Content	T152	C231	Refer to 23.4.1.1; 23.5.3.C and Table 23-3
Compressive Strength	T22	C39	Refer to 23.4.1.1; 23.5.3.C and Table 23-4
Obtaining Cores	T24	C42	As required or directed
Compressive Strength of Cores	T24	C42	As required or directed
Aggregate Base Course			
Gradation	T27	C136	Per source or as required or directed
Moisture-Density (Proctor)			Per source or as required or directed
Modified	T180	D1557	As specified in Geotechnical Report
Standard	T99	D698	As specified in Geotechnical Report
Density/ Moisture Content			1/1000 lf/Lane--Min. 1 per street

23.1.3 Material Specifications

A. General.

The Specifications presented in this section are performance oriented. The Local Entity's objective in setting forth these Specifications is to achieve an acceptable quality of roadway structures.

B. List of Materials to Be Annually Approved by Local Entity.

All sources for the mined or manufactured materials that are listed below shall be annually tested by the supplier and approved by the Local Entity Engineer for compliance with the appropriate materials performance specifications. No material sources shall be used for public improvement construction without approval of the Local Entity Engineer. For the purpose of these Standards, public improvements are all roadway improvements, driveways, sidewalks, curbs and gutters, crossspans, ramps, structures, and other public infrastructure within Local Entity right-of-way, or within a public access easement.

1. The following materials shall be annually approved:
 - a. Concrete mix design
 - 1) Admixtures, water reducing agents, and accelerators
 - 2) Air-entraining agents
 - b. HBP mix design
 - c. Admixtures, water reducing agents, and accelerators
 - d. Fly ash
 - e. Aggregate base course material
 - f. Flowable concrete fill
2. The following additional materials may be required to be tested and approved at the discretion of the Local Entity Engineer:
 - a. Liquid membrane curing compound (white pigmented liquid linseed oil based curing compound) shall conform to **ASTM Specification C309-81 Type II, Class B.**
 - b. Polyethylene sheets
 - c. Expansion joint material
 - d. Welded steel wire fabric
 - e. Lime
 - f. Aggregate
 - g. Pipe materials

- h. Geotextile/Fabric
- i. Steel rebar
- j. Signage materials
- k. Striping materials
- l. Traffic signal materials
- m. Lighting types

C. Procedure for Material Source Approval.

On or before April 1 of each year, or a minimum of 14 calendar days before construction, a material supplier for any Local Entity public improvements shall supply written documentation and material test results from a competent materials testing laboratory that describes:

1. Material(s) being tested to meet Local Entity specifications
2. The test procedures employed
3. The supplier's manufacturing, mining, or treating process by which the tested materials were created
4. The material test results
5. A signed statement by the material supplier that the materials to be provided for public improvements in the Local Entity during the coming 365 day period have been tested within the last sixty days.

D. Violations of Approval Conditions

1. Random Testing. The Local Entity Engineer may order random tests of materials used in Local Entity public improvements to verify compliance with material specifications.

Any and all material used to construct Local Entity public improvements that is not from a certified source, or that is from a certified source and fails one or more random material tests, may be subject to complete removal as a condition of Local Entity acceptance of that public improvement. Additional tests will be required to confirm the existence and extent of the substandard material prior to the initiation of remedial action. The extent of the material to be removed will be at the discretion of the Local Entity Engineer.

2. Materials Not Listed in Section 23.1.3 B. Other permitted materials include those deemed by the Local Entity to be the primary structural materials commonly or typically used in public improvements. Ancillary public improvement materials such as manufactured paints and coatings, bonding agents, sealers, gaskets, insulating materials, etc., should be in compliance with Colorado Department of Transportation material specifications for the appropriate material employed.

Decisions on acceptability of alternative materials will be made by the Local Entity Engineer.

23.2 RIGHT-OF-WAY AND PUBLIC EASEMENT GRADING

23.2.1 Soil Testing

A. Referenced Standards.

All testing shall be done in accordance with testing methods of **AASHTO** or **ASTM** as designated in **Table 23-1**.

B. Moisture-Density Determination.

A moisture-density determination shall be taken for each soil type encountered. For A-6 and A-7 soils, **AASHTO T99** shall apply.

C. Compaction.

Refer to **Chapter 22, Construction Specifications**, for compaction criteria. Also refer to **Table 23-1** for the material test method.

D. Imported Fill.

All imported fill material shall be tested and accepted in accordance with **Chapter 5, Soils Investigations and Report**, prior to placement of any fill material.

E. Frequency of Testing.

Refer to **Table 23-1**.

23.2.2 Erosion Control

A. Fort Collins (city limits only)

Refer to City of Fort Collins Storm Drainage Standards

B. Rip-Rap

1. Materials. For riprap, plastic filter cloth, and impervious plastic lining material criteria, refer to the discussion of erosion control in **Chapter 22, Materials and Construction Specifications**.
2. Construction Requirements.
 - a. Plastic Filter Cloth. If, in the opinion of the Local Entity Engineer, field lap joints of plastic filter cloth or impervious plastic lining are necessary, refer to the discussion of erosion control in **Chapter 22, Materials and Construction Specifications**.

C. Plant Preparation.

Plant inspection and acceptance shall be done prior to installation according to **CDOT Specification Section 214.02 (b)**.

D. Lawns and Grasses (Sod and Seeding).

Inspection of materials will be limited to that shown by the submittals outlined in the erosion control discussion in **Chapter 22, Materials and Construction Specifications**.

23.3 TRENCHING FOR UTILITIES

23.3.1 Excavation for Utility Trench

A. Construction Inspection.

Inspection of construction shall be provided, as frequently as necessary, to confirm that the construction conforms to the plans and specifications. The Developer shall notify the Local Entity 24 hours prior to placement of trench backfill.

23.3.2 Bedding

Inspection of bedding material is the responsibility of the utility owner and is not governed by these standards. Refer to the utility standards.

23.3.3 Backfilling

A. Inspection.

Inspection of backfill materials shall be made prior to installation to determine compliance with these Standards. Refer to **Table 23-1** for compaction requirements. All backfill compaction shall meet the compaction requirements. Compaction testing shall be required for all utility trench backfill. Trench backfill placement within public easements, as well as the right-of-way, shall be observed and accepted by the Local Entity Engineer and shall meet these requirements.

23.4 STRUCTURES

23.4.1 Concrete Structure Inspections

This section delineates the testing, inspection, and related documentation requirements for all structures, including bridges, retaining walls, cast-in-place box culverts, and other concrete structures specified within.

A. Concrete Mix Design.

Concrete mix designs shall be performed according to **Section 23.5.1**.

B. Plan and Specifications Review.

It is the Developer's responsibility to familiarize the materials testing firm with the plans and specifications approved by the Local Entity Engineer prior to any construction.

C. Structural and Inspection Requirements.

The structural design Engineer or his representative, familiar with assumptions inherent in the structure design, shall inspect the construction in sufficient detail to confirm that the construction meets the requirements of the plans and specifications.

D. Specialty Inspection.

Specialty inspection of construction may be required, as frequent as necessary to confirm that the construction conforms to the plans and specifications, by qualified personnel experienced in the inspection of similar structures. A written log or report of all work shall be furnished to the Local Entity Engineer at or prior to the request for initial acceptance of the structure. These inspection costs shall be borne by the Developer in addition to any other inspection fees required in **Section 23.8**. All bridges and major drainage structures with a span greater than twenty feet shall be inspected and rated in accordance with CDOT bridge rating criteria, to meet proper rating for a new bridge, prior to the structure's acceptance by the L.E.

E. Material Testing Requirements

Testing of materials shall conform to the requirements of **AASHTO** "Standard Specifications for Highway Bridges," latest edition, and applicable interims, as well as applicable **CDOT** standards.

F. Foundation Testing and Inspection Requirements.

Unstable foundation material shall be removed to a depth approved by the Local Entity Engineer below the finish grade elevation and be replaced with a material and construction procedure as approved by the Local Entity.

G. Inspection of Forms and False Work

1. The forms shall be clean of all dirt, mortar, and all foreign material. Forms that will later be removed shall be thoroughly coated with an approved form oil.
2. The forms shall be mortar tight and of a quality (in addition to the bracing) to withstand the pressures from deposited concrete.
3. Unless otherwise specified, forms for exposed surfaces shall be constructed with triangular fillets 3/4 inch at all exterior corners.

H. Inspection of Reinforcing Steel

1. Material Grade and Size. The material grade and size shall be as specified by the Designer on the certified construction plans.

2. Tying.

a. The intersections of all bars shall be tied in accordance with the following requirements: Slab bars shall be tied at every intersection around the periphery and at spacing according to bar sizes. Unless bar spacing is less than 12” in which case every other intersection shall be tied. However, in no case shall less than 30% of the intersections be tied.

b. Wall bars should be tied sufficiently to prevent shifting, at least 3 times in any bar length at every third or fourth intersection and at spaces according to bar sizes, staggered:

#5 and smaller	- 3'0"
#6 to #9	- 4'0" to 5'0"
#10 to #11	- 6'0" to 8'0"

Upper and lower mats shall be tied or otherwise fastened at 4 foot maximum spacing in each direction. Minimum splice length shall be 24 bar diameters.

- 1) All reinforcing steel shall be supported with steel chair or precast mortar.
- 2) Reinforcing steel shall be clean and free of all foreign material before concrete is placed.
- 3) All clearances shall be in compliance with approved plans and specifications.

I. Concrete Testing and Inspections

1. Materials Specifications. The class of concrete used on structures shall be in accordance with **CDOT Specifications Section 601.02** and **CDOT Table 601-1**. Concrete that does not meet strength in 28 days is subject to removal.

2. Concrete Tests.

- a. All testing shall be done in accordance with **AASHTO** or **ASTM** as designated in **Table 23-1**.
- b. Sampling and testing shall be required on all concrete work including curb, sidewalk, crosspans, pavement, ramps, slope paving, retaining walls, inlets, manholes, or any other structures.
- c. Maximum time allowed between sampling and casting cylinders shall not exceed 15 minutes. If the concrete cannot be taken to the laboratory and cylinders cast within 15 minutes, the cylinders shall be cast in the field. Cylinders shall be transported to the laboratory within 24 hours of casting but after the concrete has hardened, (see **AASHTO T23** or **ASTM C-31**).
- d. Concrete cylinders shall be load-tested and broken at the times listed on **Table 23-2**.

**Table 23-2
 Concrete Cylinder Breaks**

Number of Cylinders	Break Interval (Days)
Series (4 Cylinders) *	
1	7
2	28
1	HOLD

NOTE: Additional cylinders may be required, as directed by the Local Entity Engineer. 56-day cylinder shall be used if 28-day cylinder strength is less than the required design strength.

* For high strength early concrete operations a minimum of one additional cylinder shall be poured for additional breaks.

- e. The slump test shall be performed in accordance with **AASHTO T119**. The air test shall be performed in accordance with **AASHTO T196** or **T121**. Slump and air test measurements shall be taken with each cylinder series. Concrete slump and air content shall be done in accordance with **CDOT Table 601-1**.
- f. Coring. Coring is not generally permitted unless approved by the Local Entity Engineer and if approved, the section cored shall be repaired to the satisfaction of the Local Entity Engineer.
- g. Low Strength Test Results. If compressive strength of cylinders and beams does not meet the specified values, the Professional Engineer shall recommend and the Local Entity Engineer shall approve the necessary mitigation measures needed.

J. Testing Frequency and Related Inspections

- 1. At least 4 compressive strength cylinders shall be taken from the same concrete delivery truck to provide design compliance testing at the laboratory. Two of the four specimens will be tested at 28 days for acceptance and 1 shall be tested at 7 days for information. The fourth cylinder shall only be necessary if the 28-day fails. This is required for each pour per day with at least 1 strength test series for each 75 cubic yards of concrete placed. Note: Additional cylinders may be required, as directed by the Local Entity Engineer. Cylinder strength shall be 56-day if 28-day cylinder strength is insufficient for the required design strength.
- 2. Slump, air content, unit weight, and mix temperature shall be tested for each pour per day with at least 1 test for each 75 cubic yards of concrete placed. Standards in **Section 23.4.1 I** shall also apply.

K. Placement (Inspection)

- 1. Concrete placement shall be done in a manner such that the concrete is not segregated or altered before placing. It shall not be allowed to free fall more than 5 feet. Concrete shall be placed in lifts not to exceed 18 inches.

2. A sufficient number of vibrators shall be used to properly consolidate the concrete as required.
3. Weepholes and drainage systems should be installed in the structure at the locations noted on the plans or specifications.
4. Construction joints and expansion joints shall be constructed in conformance with approved plans and specifications.
5. Curing concrete other than bridge decks shall be done in conformance with **CDOT Specifications Section 601.13** with a minimum curing period of 7 days.
6. Curing of bridge decks shall follow **CDOT Specifications Section 601.16**.
7. When placing concrete next to recently constructed lane (bridge decks), refer to **Section 23.6.3 C.2.k**.

L. Finishing of Hardened Concrete Surfaces

1. Unless otherwise authorized, all formed surfaces shall be given a Class 1 finish immediately following curing, as defined by **CDOT Specification 601.14**.
2. Culvert headwall and wingwall surfaces above ground, where visible from a traveled way, shall receive a **CDOT Class 2, Class 5** or approved structural concrete coating finish, as defined in **CDOT Specification Section 601.14(b)**, at the Developer's option.
3. A **CDOT Class 5** or approved structural concrete coating finish shall be given to all bridge type surfaces as noted in **CDOT Specification Section 601.14(a)**.

M. Final Surface Test (Bridge Deck).

All work shall be true to line and grade as established by the Local Entity Engineer. Prior to acceptance of the work, the Developer shall test the surfaces with a 10-foot straightedge. Any areas higher than 1/4 inch, but not higher than 1/2 inch, above the correct surface thus indicated shall be ground to the correct surface by the Developer at his expense. When the deviation exceeds the foregoing limits, the Developer shall remove and replace that portion of the work at his expense, as directed by the Local Entity Engineer. Any depressions shall be mitigated according to **CDOT Specifications Section 601.15(d)**.

The following standards where relevant shall also apply:

1. **Section 23.5.2** , Inspection Criteria.
2. **Section 23.6.3** , Portland Cement Concrete Pavement.

N. Permanent Steel Bridge Deck Forms.

Inspection and testing of concrete placement shall be done in accordance with **CDOT Specifications Section 601.10f**.

O. Bridge Deck Concrete Placing

1. Straight Edge Testing. Refer to **Section 23.4.1 M** for testing of finished surface of concrete.
2. Moveable Bridge for Inspection. A moveable bridge or platform shall be provided for inspection in accordance with **CDOT Specifications Section 601.15e**.

P. Waterproofing Membrane.

Measurement of waterproofing membrane effectiveness shall be done in accordance with **CDOT Specifications Section 515.04(h)**.

23.4.2 Structural Steel

A. Material and Certification Testing.

Material mill test reports shall be furnished in accordance with **CDOT Specifications Section 509.13**. Suppliers test reports for fasteners and fastener requirements shall be in accordance with **CDOT Specifications Section 509.28**.

B. Fabrication Testing.

Fabrication notice, inspection and testing shall be submitted and/or implemented in accordance with **CDOT Specifications Sections 509.14, 509.17 and 509.18**.

C. Field Welding and Erection.

Inspection of field welding and erection of steel structures shall be in accordance with **CDOT Specifications Sections 509.26 and 509.27**.

23.4.3 Timber

A. Materials Inspection.

All treated and untreated timber furnished shall be inspected in accordance with **CDOT Specifications Section 508.04**.

23.4.4 Bearing Device

A. Fabrication Testing.

Completed bearings shall be tested and approved in accordance with **CDOT Specifications Section 512.09**.

23.5 NON-STRUCTURAL CONCRETE

Non-structural concrete includes curb, gutter, walks, driveways, crosspans, and ramps.

23.5.1 Concrete Mix Design

Concrete mix design shall be performed in accordance with the provisions of **CDOT Specifications 601.05**. A separate mix design shall be provided if pumped concrete is used. These shall be submitted no less than 5 working days prior to placement of any concrete.

23.5.2 Inspection Criteria

A. Tolerances for Repairs or Replacement of Work

1. Humps and Depressions. Any localized humps and/or depressions greater than 1/4 inch (as measured with a 10-foot straight edge) will require removal and replacement of the work in question.
2. Water Ponding. No ponding of water, according to **Section 23.5.3 B.3.a**, shall be allowed.
3. Flowline Depth. Combination curb, gutter, and walk and/or vertical curb and gutter flowline depth shall not vary from adopted standards by more than $\pm 1/4$ inch, measured vertically from the top of curb to the gutter invert.
4. Cross Slope in Pedestrian Walks. Pedestrian walks shall have a minimum of 1.0 percent and a maximum of 2.0 percent cross slope, unless otherwise approved by the Local Entity Engineer.
5. Joint Spacing. Contraction and construction joints shall be placed at a maximum spacing of 10 feet in curb, gutter, sidewalks, crossspans, trickle channel, etc. A minimum spacing of 6 feet will be allowed.
6. Heave or Settlement of Sidewalk. Heave or settlement of sidewalk, relative to separate curb pour, greater than 1 inch in Loveland (GMA and city limits) and 1/2" in Ft. Collins (GMA and city limits), shall be cause for corrective action.

B. General Specifications

1. Utility Facilities Placement. No utility facilities shall be placed in curb, gutter, or walk, crossspans, etc., unless shown on the approved construction plans. This includes water stop box, manholes, power poles, fire hydrants, water valves, etc.
2. Concrete Cracks.
 - a. At the time of preliminary or final acceptance inspection, no cracks outside of the control joint will be accepted and shall be removed to the nearest control joints. Time of replacement (preliminary acceptance) shall be decided by the Local Entity Engineer.
 - b. At the time of final acceptance inspection, the repair of all cracks will be completed.
 - 1) Any longitudinal cracked section of concrete will require complete removal and replacement of that section between joints.

- 2) Repair action for hairline cracks may be waived at the discretion of the Local Entity Engineer. For the purpose of this section, a hairline crack is one that is reasonably immeasurable and without separation as determined by the Local Entity Engineer.
3. Concrete Chips.
 - a. One chip that penetrates into the gutter pan or back of walk 2 inches or more and is 5 inches or longer in one stone will require removal and replacement.
 - b. Four or more chips that penetrate 1 inch or more and are 4 inches or longer in one stone will require removal and replacement.
4. Concrete Gouges (to any surface of the curb, gutter, and walk). The following requires removal and replacement of the damaged panel/stone:
 - a. One gouge that penetrates 3/4 inch or deeper and covers an area of 10 square inches.
 - b. Two gouges that penetrate 1/2 inch or deeper and cover a combined area of 15 square inches.
 - c. Three gouges that penetrate 1/4 inch or deeper and cover a combined area of 25 square inches.
 - d. Four gouges that penetrate 1/8 inch or deeper and cover a combined area of 35 square inches.
5. Other Imperfections in Concrete Surface. Stress cracking, D-cracking, pop-outs, spalling, rain damage, graffiti, and other surface defects will remain discretionary and will usually require removal and replacement.
6. Final Grade.
 - a. A light broom finish (not to expose the aggregate) to all concrete shall be required.
 - b. All concrete work shall have the proper finished grade. No reversal of the flow direction will be accepted by Local Entity.
 - c. No abrupt changes in grade shall be allowed, i.e., curb returns from new to existing, driveway entrances, etc.

C. Additional Inspection Requirements for Repairs

Follow the guidelines in **Chapter 25, Reconstruction and Repair**, concerning repairs.

23.5.3 Concrete Testing and Inspections

A. Materials Specifications.

Compressive strength of non-structural concrete shall be 3500 psi at 28 days. For additional specifications refer to **Section 23.4.1 I**.

B. Concrete Tests

1. Testing and Sampling Standards. Refer to **Section 23.4.1 I** for the following standards:
 - a. Sampling and Testing
 - b. Sampling Time
 - c. Slump and Air Tests
 - d. Coring
2. Concrete cylinders shall be load-tested and broken at the times listed in **Table 23-2**.
 - a. The testing laboratory and Local Entity Engineer shall determine the areas of concrete with potentially low strength and clearly denote the areas to the Developer.
 - b. The Developer shall have an independent testing laboratory, acceptable to the Local Entity Engineer, obtain and cure core samples per **ASTM C 42** or **AASHTO T 24**. A minimum of 3 samples shall be taken for each 100 cubic yards or fraction thereof of concrete in question.
 - c. Strength level of concrete in the area represented by core tests will be considered adequate when the average compressive strength of the cores are equal to at least 85% of specified compressive strength and if no single core is less than 75% of the specified compressive strength.
 - d. If the concrete is determined not to have adequate strength, the Local Entity Engineer may require the Developer to replace low strength areas.
3. Grade Verification of Gutter Flowline.
 - a. After completion of curb and gutter, including curb returns and crosspans, and prior to installation of asphalt, the new installation must be flow-tested with water to confirm that there are no areas that hold water. The Local Entity Engineer will confirm the results and accept or reject the work. The work will not be accepted if it holds water more than 1/4 inch deep for a distance greater than 5 feet. Unacceptable work must be removed and replaced.
 - b. After completion of curb, gutter, radii, and crosspans, the Developer must provide to the Local Entity Engineer a field verification of critical elevations to ensure the construction complies with the approved plans. The verification

must include flowline elevations at intersections, high points, and inlets. The Developer must provide the Local Entity with the following:

- 1) A letter from a licensed Professional Engineer or Land Surveyor stating that the field verification has found the work conforms to the approved plans, and;
- 2) Mylar copies of the approved construction plans showing the actual spot elevations and profile grades must be provided. All deviations shall be noted in the letter and on the required drawings. If gutter profile grades are less than 0.4 percent, the work will not be accepted. Any field changes to the approved plans that change the profile grades by more than 0.5 of 1 percent will require revisions, by the Designer, to the original Mylar grading and street plans by the Developer and approval by the Local Entity Engineer prior to construction of improvements.

C. Testing Frequency

1. At least 4 compressive strength cylinders shall be taken from the same concrete delivery truck to provide design compliance testing at the laboratory. Two of the 4 specimens will be tested at 28 days for acceptance and one shall be tested at 7 days. The fourth specimen shall be tested at 56 days if the 28-day specimen does not conform to these specifications. This is required for each pour per day with at least 1 strength test series for each 75 cubic yards of concrete placed. Additional cylinders may be required to determine the rate of strength gain on high-early concrete mixes.
2. Slump, air content, unit weight, and mix temperature shall be tested for each pour per day with at least 1 test for each 75 cubic yards of concrete placed. Also refer to the slump and air testing requirements in **Section 23.4.1 I**.

D. Placement Standards

1. Refer to **Section 23.4.1 I** for the following.
 - a. Free Fall and Lifts
 - b. Vibrators
2. Refer to **Chapter 22, Construction Specifications**, concerning non-structural concrete curing for the following:
 - a. Joints
 - b. Curing Concrete

E. Finishing Standards for Hardened Concrete Surfaces.

Refer to **Section 23.4.1 L**.

F. Backfill.

Compaction of soil placed behind the curb in landscaped areas shall be compacted to 90 percent standard Proctor density.

23.6 PAVEMENT

23.6.1 Subgrade and Roadbed

A. Subgrade Approval

1. Inspection. When the Local Entity Engineer determines an unsatisfactory soil is present, excavate and replace with suitable material.
2. Reconstruction. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Local Entity Engineer.

B. Subgrade Preparation

1. Testing. Field moisture-density tests using acceptable methods will be required at random locations. Refer to **Chapter 22** for soil types and compaction percentages for **AASHTO T99** and **T180** tests.
2. Acceptance.
 - a. Compaction. The results of field density tests shall be submitted and reviewed by the Local Entity Engineer prior to placing the next course. Should testing indicate results less than those specified, the necessary reworking, compaction, or replacement will be required prior to continuation of the paving process. The approval is valid only to a time when weather conditions may have changed the condition of the subgrade. Changes in weather such as freezing or precipitation, which may cause changes in the subgrade, will require re-approval of the subgrade. Refer to **Chapter 22, Construction Requirements**, concerning subgrade preparation for compaction criteria.
 - b. Final Proof-Rolling. Final proof rolling of subgrade shall be required prior to placing base. Refer to **Chapter 22, Construction Requirements**, concerning subgrade preparation.

C. Soil Stabilization

1. Lime Stabilization. The field placement of lime must comply with design requirements in Chapter 5, Soils Investigation and Report and Chapter 22, Materials and Construction Specifications.
 - a. Design Testing Summary. Tabulated summaries of laboratory test results for field samples, composite samples, and lime-soil mixes shall be provided to the Local Entity Engineer written 24 hours and include the following:
 - Field Sample No. (also shown on map)
 - Group No. (composite sample)

Soil description
#200 sieve analysis
Atterberg limits
AASHTO classification and group index
% soluble sulfates
pH value
Maximum dry density
% optimum moisture content
% stabilization agent content
% swell
Compressive strength

2. Fly Ash Stabilization. Consult the Local Entity's Engineer for requirements for this special case. Also see **Table 10-4, Pavement Strength Coefficients**.
 - a. Kiln Dust Stabilization. Consult the Local Entity's Engineer for requirements for this special case. See **Table 10-4, Pavement Strength Coefficients**. Construction Requirements must be specified by the Designer and approved by the Local Entity Engineer.

23.6.2 Base Course

A. Aggregate Base Course Material

1. Testing Frequency. Aggregate base course shall be tested for compaction and moisture once every 1000 feet for each lane.
2. Approval of Sources. Approval of sources will, at a minimum, consist of supplying documented gradation, Atterberg limits, and R-value testing on an annual basis.

23.6.3 Portland Cement Concrete Pavement

A. Concrete Mix Design.

Refer to **Section 23.5.1** .

B. Concrete Testing and Inspections.

Concrete shall conform to the requirements for Class “P” (4200 psi) concrete as specified in CDOT subsections 601.02 and 601.03. When the quantity of pavement concrete is too small to make use of mechanical equipment practical, the contractor will be permitted to use **AASHTO M43** size 57 or 67 aggregate in lieu of coarse concrete specified in **CDOT Table 601.01**.

C. Concrete Roadway Inspection for Repairs or Replacement Work

1. Tolerances.

- a. All manholes, water valves, range boxes, etc., shall be flush to 1/4 inch below the final surface roadway grade. Refer to **Section 23.7.1** for adjustments to final grade.
 - b. Where the constructed surface varies from the design cross slope by more than 1/2 inch in 10 feet, the pavement shall be removed and replaced. This technique may not apply in areas with less than 2% cross slope.
 - c. Areas showing high spots greater than 1/4 inch as measured with a 10-foot straight edge, but less than 1/2 inch, may be diamond ground to within the specification of 1/4 inch. High spots more than 1/2 inch may be permitted, if acceptable to the Local Entity Engineer.
 - d. Thickness Tolerance. The thickness of the pavement shall be determined by average caliper measurement of cores tested, if required by the Local Entity Engineer. A minimum of 2 cores per 1000 square yards will be taken at random. Should any deviation be found, additional cores may be taken to define the horizontal limits of the deviation. When measurement of the core from a unit is not deficient by more than 1/4 inch from the design thickness, the pavement thickness will be considered to be within acceptable tolerance. When such measurement is deficient more than 1/4 inch and not more than 1 inch from the design thickness, two additional cores at intervals not less than 300 ft will be taken and used to determine the average thickness for that area. When the thickness of pavement is deficient by more than 1 inch the Local Entity Engineer may require that the area be removed and replaced.
2. Specifications.
- a. All panels with cracks wider than 1/8 inch shall be repaired by total removal of the panel and replacement as required by the criteria herein. At the time of initial acceptance no cracks will be allowed and shall be repaired on full panel basis.
 - b. All panel cracks 1/8 inch and narrower may be routed and sealed at the discretion of the Local Entity Engineer.
 - c. There shall be no more than one structural crack per panel. Panels with more than one structural crack shall be repaired by total panel removal and replacement.
 - d. All sections removed shall have edges parallel to adjacent panel joints.
 - e. All saw cuts for removal of slabs shall be full depth cuts.
 - f. No panel shall be allowed that has a crack meeting an adjacent panel at an angle more acute than 45 degrees to a finished edge or control joint.
 - g. All corner cracks to a panel shall be removed and replaced as required by the criteria contained herein.
 - h. Any vertical differential movement across a crack greater than 3/16 inch shall be repaired by either partial or total panel removal and replacement.

- i. All panels with faulted joints resulting from settlement, pumping, and/or curling of the edges shall be repaired by removal and replacement, or in the case of curling, may be repaired by grinding at the discretion of the representative of the Local Entity.
- j. All joint seal damage that allows the intrusion of water or foreign material shall be cleaned and replaced in accordance with **CDOT 412-18**.
- k. Where concrete is to be placed adjoining a previously constructed lane of pavement and heavy equipment will be operated upon the existing lane, that lane shall have attained a 3000 psi compressive strength, prior to its use. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted when that lane has attained a 3000 psi compressive strength.
- l. All compaction shall meet the requirements of these Standards.
- m. Any other defect not mentioned but noted as a problem by the Local Entity Engineer shall be repaired or replaced per these specifications.

23.6.4 Hot Mix Asphalt (HMA)- Superpave Method

A. HMA Testing and Reporting

1. All testing shall be done in accordance with **AASHTO**, **ASTM**, or **Colorado Procedures (CP)**, as designated throughout this chapter.
2. In addition to the requirements of **Table 23-1** all reports shall include elevation or depth below finish grade at which test was taken. Results shall report densities (maximum dry and relative) to nearest 0.1lb/ft³, and compaction (relative and required) to nearest 0.1 percent, results of the daily standardization checks, and the most recent adjusted manufacturer's calibration curve. The manufacturer's calibration curve shall be adjusted as required by ASTM D2950 whenever a change in either the material to be tested or the testing equipment is made. If a nuclear device is used, the report shall contain the method used (i.e. back scatter, direct transmission, etc.)
3. In-place pavement thickness shall be determined as follows, if requested by Local Entity Engineer: The pavement shall be cored at 500 foot intervals, or fraction thereof, in each 12 foot lane (nominal), with a minimum of 3 cores in any area. The Local Entity Engineer may require additional cores to define deficient areas. Core samples shall be taken prior to final lift. Pavement section shall be within ¼" of design thickness.

B. Conformity with Plans and Specifications.

Conformity to the Standards for all hot mix asphalt, CDOT Item 403 will be determined by tests and evaluations of asphalt content, aggregate gradation, and in-place density.

C. PG Asphalt Binder Testing and Certification

Local Entity can sample and test binder from bank at plant. If requested, supply c.o.c. of binder properties and deliver tickets to plant.

1. If requested by the Local Entity, the developer shall provide the Local Entity a safe access to the binder storage tanks at the asphalt plant and shall provide information and assistance as required for the Local Entity to make a complete and detailed inspection; including sampling of the binder for acceptance testing. All costs associated with providing access and assistance as well as the cost of the binder sampled shall be considered subsidiary to the work and will not be paid for by the Local Entity. The costs of all acceptance testing performed on the PG binder will be paid for by the local entity. It shall be the responsibility of the developer to reimburse the Local Entity for the cost of all failed tests and be responsible for additional testing to assure that the binder is back in compliance.

If the testing indicates that the binder is not in compliance with the requirements of Table 23-3 the developer shall correct the deficiencies at the direction of the Local Entity, including removal of the pavement if deemed necessary by the Local Entity.

2. If requested by the Local Entity, the developer shall supply copies of the “Certificate of Compliance” and “Certified Test Reports” from the binder supplier. These submittals shall meet all requirements of CDOT Standard Specifications for Road and Bridge Construction Section 106.09 and 106.10 respectively.

Binder furnished on the basis of “Certificates of Compliance” and “Certified Test Reports” may be sampled and tested by the Local Entity to determine compliance with the applicable specifications.

3. If requested by the Local Entity, the developer shall provide the Local Entity with copies of the load delivery tickets for the binder supplied to the asphalt plant. These load delivery tickets shall include the following information:
 - a. Date and time of delivery
 - b. Address of delivery
 - c. Type and grade of binder delivered
 - d. Quantity of binder delivered
 - e. Lot or batch number

D. Bituminous Pavement Inspection for Repairs or Replacement Work

1. Surface Tolerance. The finished surface of the bituminous pavement, when tested with a 10-foot straightedge parallel to the centerline or perpendicular across joints, will show variations as measured from the testing face of the straightedge to the surface of the pavement, which shall not exceed 1/4 inch. Areas that do not meet the required surface accuracy shall be clearly marked and if the Local Entity Engineer requires repair, the Developer shall repair the pavement.

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Section 23.6 Pavement

2. Thickness Tolerance. Any deficiency in the total thickness of the asphaltic pavement shall not exceed 10 percent for any one sample with the average deficiency for all samples not to exceed 7.5 percent. Final decision for correction of deficiencies shall not be made until a pavement evaluation is made by an independent testing laboratory.

**Table 23-3
SuperPave Performance Graded Binders**

Property	Requirement For P _g Binder						AASHTO Test No.
	58-28	58-34	64-22	64-28	70-28	76-28	
Original Binder Properties							
Flash Point Temp., °C, minimum	230	230	230	230	230	230	T28
Viscosity at 235°C, Pa•s, maximum	3	3	3	3	3	3	TP 48
Dynamic Shear, Temp. °C, where $G^*/\sin \delta @ 10 \text{ rad/s} \geq 1.00 \text{ kPa}$	58	58	64	64	70	76	TP 5
Ductility, 4°C (5cm/min.), cm minimum	-	-	-	50	-	-	T 51
Toughness, joules (inch-lbs)	-	-	-	12.4 (110)	-	-	*CP L-2210
Tenacity, joules (inch/lbs)	-	-	-	8.5 (75)	-	-	*CP L-2210
RTFO Residue Properties							T240
Mass Loss, percent maximum	1.00	1.00	1.00	1.00	1.00	1.00	T240
Dynamic Shear, Temp. °C, where $G^*/\sin \delta @ 10 \text{ rad/s} \geq 2.20 \text{ kPa}$	58	58	64	64	70	76	TP 5
Elastic Recovery, 25°C, percent min.	-	-	-	-	50	50	*CP L-2211 Method A
Ductility, 4°C (5 cm/min.), cm minimum	-	-	-	20***	-	-	T 51
PAV Residue Properties, Aging Temperature 100°C							PP 1
Dynamic Shear, Temp. °C, where $G^*/\sin \delta @ 10 \text{ rad/s} \geq 5000 \text{ kPa}$	19	16	25	22	25	28	TP 5
Creep Stiffness, @60 s, Test Temperature in °C	-18	-24	-12	-18	-18	-18	
S, maximum, Mpa	300	300	300	300	300	300	TP 1
m-value, minimum	0.300	0.300	0.300	0.300	0.300	0.300	TP 1
**Direct Tension, Temperature in °C, @ 1 mm/min., where failure strain $\geq 1.0\%$	-18	-24	-12	-18	-18	-18	TP 3
<p>* Colorado Procedure. ** Direct tension measurements are required when needed to show conformance to AASHTO MP 1. *** If the PG 64-28 RTFO residue fails the ductility test, the binder will be accepted if the TFO residue (AASHTO T 179) has a ductility of 25 cm or more.</p>							

23.7 MISCELLANEOUS

23.7.1 Bituminous Pavement Inspection for Repairs or Replacement

A. **Surface Tolerance.** Refer to Section 23.6.4 D.1.

B. **Thickness Tolerance.** Refer to Section 23.6.4 D.2.

C. **Rim Tolerance.**

All manholes, water valves, range boxes, etc., shall be 1/4 inch to 5/8 inch below the final paved grade.

D. **Cracks.**

Individual and nondeflecting cracks in the asphalt shall, at the discretion of the Local Entity Engineer, be sealed with rubberized asphalt sealant approved by the Local Entity Engineer, to include cracks or open sawed joints at patch areas.

E. **Additional Requirements for Repairs (Patching).** Refer to Chapter 25, Reconstruction and Repair.

23.7.2 Manhole Frames and Valve Boxes

To provide proper protection to the public, manhole frames and covers and valve boxes shall be accessible no later than 24 hours after they have been buried by the work in progress. Prior to placement of the final lift of pavement, manhole frames and covers and valve boxes and all other similar devices that must be accessed from the surface should be raised to final grade. After final adjustment, the Developer shall notify the Local Entity Engineer who shall make an inspection to check for grouting of the manhole frame, cleanliness and proper alignment, elevation and slope of the grade ring. All valve boxes shall be inspected by applying a valve key to each operating nut to assure an acceptable alignment.

After inspection and acceptance by the Local Entity Engineer of the manhole frames and covers and valve boxes, the Developer shall proceed with the final wearing surface.

All materials necessary for adjusting manholes or valve boxes as required by resurfacing must be on hand at the job site prior to placement of any asphalt or concrete pavement.

A. **Adjustment for Asphalt Pavements.**

If manhole frames and covers and valve boxes are adjusted to final grade between any two lifts of bituminous pavement or within 24 hours following placement of the placement of the final wearing surface as provided for above, complete the adjustment in accordance with requirements in Chapter 25, Section 25.5.6J.

B. **Adjustment for Concrete Pavement.**

After placement of the concrete and jointing has begun, a transverse joint will be placed at each manhole frame and at each water valve box. In the event that a

manhole frame or water valve box should be covered up during construction, the Developer will be responsible for raising the manhole frame or water valve box up through the concrete. This work will take place no later than 24 hours after completion of the work. The adjustment shall be made in accordance with requirements in **Chapter 25, Section 25.5.5F**.

23.7.3 Traffic Signs, Striping, and Signals

A. Materials.

All materials shall be tested and sampled according to **CDOT Specifications Sections 708.09** and **713.09**.

B. Installation/Application.

The Local Entity Engineer shall verify that traffic control devices are installed or applied at appropriate locations as shown on the approved signing and striping plans.

All striping layouts will be reviewed by the Local Entity Engineer prior to any installation of paint or markings. The Local Entity requires a 48-hour notice before any application for inspection or approval.

The Local Entity Engineer shall approve tabs and markings prior to permanent installation of striping and symbols.

23.7.4 Streetscape in Fort Collins (City Limits Only)

See **Appendix “C” – City of Fort Collins Streetscape Design Standards and Guidelines**.

23.8 INSPECTION FEES

23.8.1 Fees for Inspection by Local Entity's Staff

The inspection shall be performed by the Local Entity’s staff. The fees for inspection shall be in accordance with current fees adopted by the Local Entity and shown in **Appendix “B”**.

23.8.2 Payment of Fees by Developer

The Developer is required to fund all costs associated with the inspection. In Loveland (city limits only), the inspection fees are paid in arrears by the builder at the time a building permit is issued. In Fort Collins (GMA and city limits) and Loveland (GMA only), the Developer pays all inspection fees in full prior to issuance of the Development Construction Permit.

23.9 STOP WORK ORDER

The Inspector is authorized to issue Stop Work Orders, as described in **Chapter 6, Permits**. In Fort Collins (city limits only) Construction Inspectors are authorized to issue

a municipal court summons for refusal by the Developer or any person who refuses to stop work.