



## SECTION 32 16 00

### SIDEWALKS, CURBS, AND GUTTER

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Concrete WORK shall consist of air entrained Portland cement constructed on a prepared subgrade in accordance with these SPECIFICATIONS. The completed WORK shall conform to the thicknesses and typical cross-sections shown on the DRAWINGS. The completed WORK shall conform to the lines and grades shown on the DRAWINGS or to those established by ENGINEER at the job site.

##### 1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 01 57 19, Temporary Environmental Controls
  - 2. Section 31 23 00, Excavation and Fill.
  - 3. Section 31 23 19, Dewatering.
  - 4. Section 31 23 33, Trenching and Backfilling.
  - 5. Section 31 25 00, Erosion and Sedimentation Controls

##### 1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Association of State Highway and Transportation Officials (AASHTO):
    - a. M6, Standard Specification for Fine Aggregate for Hydraulics Cement Concrete.
    - b. M80, Standard Specification for Coarse Aggregate for Hydraulics Cement Concrete.
    - c. M148, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
    - d. M154, Standard Specification for Air-Entraining Admixtures for Concrete.
    - e. M171, Standard Specification for Sheet Materials for Curing Concrete.
    - f. M182, Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.
    - g. M194M/M194, Standard Specification for Chemical Admixtures for Concrete.



- h. T22, Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens.
  - i. T23, Standard Method of Test for Making and Curing Concrete Test Specimens in the Field.
  - j. T26, Standard Method of Test for Quality of Water to Be Used in Concrete.
  - k. T27, Sieve Analysis of Fine and Coarse Aggregates
  - l. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - m. T11, Standard Method of Test for Clay Lumps and Friable Particles in Aggregate.
  - n. T119M/T119, Standard Method of Test for Slump of Hydraulic Cement Concrete.
  - o. T121M/T121, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
  - p. T141, Standard Method of Test for Sampling Freshly Mixed Concrete.
  - q. T152, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
  - r. T176, Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
  - s. T199, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Chace Indicator.
2. ASTM International (ASTM):
- a. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
  - b. C920, Standard Specification for Elastomeric Joint Sealants.
3. Colorado Department of Transportation (CDOT):
- a. Section 703.01, Fine Aggregate for Concrete.
  - b. CP30, Sampling of Aggregates.
  - c. CP31A, Sieve Analysis of Fine and Coarse Aggregates.
  - d. CP60, Determining Surface Moisture in Fine and Coarse Aggregates.

#### 1.04 SUBMITTALS

- A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.



- B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.
- C. Contractor shall submit mix design for concrete in writing to ENGINEER for approval prior to placement of concrete.
- D. CONTRACTOR shall submit batch tickets for each load of concrete. Tickets shall show weight of all materials and additives used in each batch.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Concrete Conformance:
  - 1. Concrete shall conform to the following requirements:

<b>Concrete Requirements</b>	
28-Day Field Compressive Strength	3,500 psi
Cement/Fly Ash	600 lbs./cu. yd.
Max. Water/Cement Ratio	0.53
Air Content % Range	5-8
Maximum Slump	4"
Fine Aggregate (max. % of total Aggregate)	50%

- 2. This material shall consist of a mixture of coarse and fine aggregates, Portland cement, water and other materials or admixtures as required. The type of cement shall be Type I, II, or I/II unless sulfate conditions dictate otherwise. If sulfate conditions exist, Type V cement shall be used.
- B. Concrete Aggregates: The grading and composition requirements for coarse and fine aggregates for concrete shall conform to the following tables.

<b>Coarse Aggregates for Portland Cement Concrete</b>	
<b>Sieve Size or Test Procedure</b>	<b>% Passing or Test Requirement</b>
1 inch	100
¾ inch	90-100
⅝ inch	20-55
No. 4	0-10
No. 8	0-5
% Wear	45, Max
Clay Lumps * Friable Particles, %	2.0, Max
Coal & Lignites, %	0.5, Max



<b>Coarse Aggregates for Portland Cement Concrete</b>	
<b>Sieve Size or Test Procedure</b>	<b>% Passing or Test Requirement</b>
Sodium Sulfate Soundness %	12, Max

<b>Fine Aggregates for Portland Cement Concrete</b>	
<b>Sieve Size or Test Procedure</b>	<b>% Passing or Test Requirement</b>
3/8 inch	100
No. 4	95 - 100
No. 16	45 - 80
No. 50	10 - 30
No. 100	2 - 10
No. 200	3, Max
Friable Particles, %	1.0, Max
Coal & Lignite, %	1.0, Max
Deleterious Material (AASHTO T112),%	3, Max
Sand Equivalent (AASHTO T176),%	80, Min
Fineness Modules	2.50 - 3.50
Sodium Sulfate Soundness, %	20.0, Max

- C. Coarse Aggregate for Concrete: Coarse aggregates shall conform to the requirements of AASHTO M80, except that the percentage of wear shall not exceed forty-five (45) when tested in accordance with AASHTO T96. Coarse aggregate shall conform to the grading in above table.
- D. Fine Aggregate for Concrete: Fine aggregates shall meet Colorado Department of Transportation, Section 703.01 requirements and gradation as shown above. Fine aggregate for concrete shall conform to the requirements of AASHTO M6. The amount of deleterious substances removable by elutriation shall not exceed three percent (3%) by dry weight of fine aggregate when tested in accordance with AASHTO T11, unless otherwise specified. The minimum Sand Equivalent, as tested in accordance with AASHTO T176 shall be eighty (80), unless otherwise specified. The Fineness Modules shall not be less than two and five-tenths (2.50) nor greater than three and five-tenths (3.50), unless otherwise approved.
- E. Fly Ash and Water: Upon approval based on a satisfactory trial mix, CONTRACTOR shall have the option of substituting approved fly ash for Portland cement, up to a maximum of twenty percent (20%) by weight. The total weight of cement and fly ash shall not be less than the specified mix design.
  - 1. Fly ash for concrete shall conform to the requirements of ASTM C618, Class C or Class F. All chemical requirements of ASTM C618 Table 1-A shall apply with the exception of footnote A.



- a. Class C fly ash will not be permitted where sulfate resistant cement is required.
  - b. CONTRACTOR shall submit certified laboratory test results for the fly ash. Test results that do not meet the physical and chemical requirements may result in the suspension of the use of fly ash until the corrections necessary have been taken to ensure that the material meets the SPECIFICATIONS.
2. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Water shall be tested in accordance with, and shall meet the suggested requirements of AASHTO T26. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be enclosed so as to exclude silt, mud, grass, or other foreign materials.
- F. Concrete Curing Materials and Admixtures:
1. Curing Materials: Curing materials shall conform to the following requirements as specified:
    - a. Burlap Cloth made from Jute or Kenaf: AASHTO M182.
    - b. Liquid Membrane-Forming Compounds Curing Concrete: AASHTO M148.
    - c. Sheet Materials for Curing Concrete: AASHTO M171.
    - d. Straw shall not be used for curing unless approved by ENGINEER.
  2. Air-Entraining Admixture: Air-entraining admixtures shall conform to the requirements of AASHTO M154. Admixtures which have been frozen will be rejected. No chloride containing additives shall be permitted.
  3. Chemical Admixtures: Chemical admixtures for concrete shall conform to the requirements of AASHTO M194M/M194. Admixtures which have been frozen will be rejected.
  4. Joint Fillers: The joint fillers shall meet the requirements of ASTM C920.

### **PART 3 EXECUTION**

#### **3.01 SUBGRADE PREPARATION**

- A. The subgrade shall be excavated or filled to the required grades and lines. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with suitable material with ENGINEER's approval. Filled sections shall be compacted and compaction shall extend a minimum of six (6) inches outside the form lines.
- B. The moisture content of the subgrade shall be brought within +/- two percent (2%) of optimum moisture content and compacted to ninety-five percent (95%) of the maximum standard Proctor density (ASTM D698) for subgrade materials classified as A-4 through A-7 or ninety five percent (95%) of modified proctor density for materials classified as A-1 through A-3.



### 3.02 CONCRETE PLACEMENT

#### A. General:

1. Concrete transported in truck mixers or truck agitators shall be delivered to the site of the WORK and completely discharged within a period of ninety (90) minutes after the cement comes in contact with the mixing water or with the combined aggregates containing free moisture in excess of two percent (2%) by weight.
2. The concrete shall be placed either by an approved slip form/extrusion machine, by the formed method, or by a combination of these methods.
3. The subgrade shall be conditioned to provide a uniformly moist surface when concrete is placed.

B. Machine Placement: The slip form/extrusion machine shall be so designed to place, spread, consolidate, screed, and finish the concrete in one (1) complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogenous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

#### C. Formed Method:

1. The vertical face of previously sawed and adjacent asphalt pavement may NOT be used as a forming surface. CONTRACTOR shall use forms on front and back of all curb and gutter, sidewalks and crosspans.
2. The forms shall be of metal or other suitable material that is straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature may be used for curves having a radius of one hundred (100) feet or less. Division plates shall be metal. Where directed by ENGINEER, CONTRACTOR shall use a thin metal back form to preserve landscaping, sprinklers, etc. Form shall be straight and rigid and shall be approved by ENGINEER prior to use on PROJECT.
3. The front and back forms shall extend for the full depth of the concrete. All of the forms shall be braced and staked so that they remain in both horizontal and vertical alignment until their removal. No wooden stakes will be allowed. They shall be cleaned and coated with an approved form-release agent before concrete is placed against them. The concrete shall be deposited into the forms without segregation and then it shall be tamped and spaded or mechanically vibrated for thorough consolidation. Low roll or mountable curbs may be formed without the use of a face form by using a straight edge and template to form the curb face. When used, face forms shall be removed as soon as possible to permit finishing. Front and back forms shall be removed without damage to the concrete after it has set.



4. Should the removal of adjacent asphalt pavement be required beyond that shown in the asphalt patch detail to properly correct failed concrete sections, CONTRACTOR shall remove and replace said asphalt pavement to such an extent as to provide a smooth repair. ENGINEER shall be notified prior to commencing any additional asphalt removal.

### 3.03 FINISHING

- A. The plastic concrete shall be finished smooth by means of a wood float and then it shall be given final surface texture using a light broom or burlap drag. Concrete that is adjacent to forms and formed joints shall be edged with a suitable edging tool to the dimensions shown on the DRAWINGS.

### 3.04 JOINTING

#### A. Contraction Joints:

1. Contraction and construction joints shall be placed at the standard spacing of ten (10) feet in curb, gutter, sidewalks, crosspans, trickle channel, etc. A minimum spacing of five (5) feet shall be allowed for repairs.
2. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals not exceeding ten (10) feet for curb and gutter or five (5) feet for sidewalk. Joint depth shall average at least one-fourth (1/4) of the cross-section of the concrete.
3. Contraction joints may be sawed, hand-formed, or made by one-eighth inch (1/8") thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be hand-formed either by (1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete, or (2) inserting one-eighth inch (1/8") thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete. Where division plates are used to make contraction joints, the plates shall be removed after the concrete has set and while the forms are still in place.

#### B. Expansion Joints:

1. Expansion joints shall be constructed at right angles to the curb line at immovable structures and at points of curvature for short radius curves. Filler material for expansion joints shall conform to requirements of the requirements of ASTM C920 and shall be furnished in a single one-half inch (1/2") thick piece for the full depth and width of the joint.
2. Expansion joints in a slip-formed curb or curb-and-gutter shall be constructed with an appropriate hand tool by raking or sawing through partially set concrete for the full depth and width of the section. The cut shall be only wide enough to permit a snug fit for the joint filler. After the filler is placed, open areas adjacent to the filler shall be filled with concrete and then troweled and edged. CONTRACTOR may choose to place the filler and pour the concrete around it.
3. Alternately, an expansion joint may be installed by removing a short section of freshly extruded curb-and-gutter immediately, installing temporary holding



forms, placing the expansion joint filler, and replacing and reconsolidating the concrete that was removed. Contaminated concrete shall be discarded.

4. Construction joints may be either butt or expansion-type joints. Curbs or combined curbs-and-gutters constructed adjacent to existing concrete shall have the same type of joints as in the existing concrete, with similar spacing; however, contraction joint spacing shall not exceed ten (10) feet.

### 3.05 PROTECTION

- A. CONTRACTOR shall always have materials available to protect the surface of the plastic concrete against rain. These materials shall consist of waterproof paper or plastic sheeting. For slip-form construction, materials such as wood planks or forms to protect the edges shall also be required. Concrete damaged by rain shall be required to be removed and replaced at CONTRACTOR's expense.
- B. Concrete being placed in cold weather during which the temperature may be expected to drop below thirty-five degrees Fahrenheit (35°F), shall be suitably protected to keep the concrete from freezing until it is at least ten (10) days old. Concrete injured by frost action shall be required to be removed and replaced at CONTRACTOR's expense.
- C. CONTRACTOR shall be responsible for correcting any vandalism or defacement (graffiti) that occurs on the concrete prior to final acceptance.

### 3.06 CURING

- A. Concrete shall be cured for at least seven (7) days after placement to protect against loss of moisture, rapid temperature change, and mechanical injury prior to any overlay or reconstruction work. Moist burlap, waterproof paper, white polyethylene sheeting, white liquid membrane compound, or a combination thereof may be used as the curing material. Membrane curing shall not be permitted in frost-affected areas when the concrete will be exposed to deicing chemicals within thirty (30) days after completion of the curing period.

### 3.07 BACKFILLING

- A. The spaces in front and back of curbs shall be refilled with suitable material to the required elevations after the concrete has set sufficiently. The fill material shall be thoroughly tamped in layers.

### 3.08 SEALING

- A. Where required, concrete shall be sealed with a mixture of one-half (1/2) linseed oil and one-half (1/2) diesel fuel, unless otherwise specified by ENGINEER.

### 3.09 TOLERANCE

- A. Forms shall not deviate from true line by more than one-quarter (1/4) inch at any point.





- B. Mixed concrete shall be not less than fifty degrees Fahrenheit (50°F), nor more than eighty degrees Fahrenheit (80°F) at the time of placement in forms, unless otherwise directed.
- C. If air temperature is thirty-five degrees Fahrenheit (35°F) or less at the time of placing, ENGINEER shall require water and/or aggregate heated to not less than seventy degrees Fahrenheit (70°F), or more than one-hundred fifty degrees Fahrenheit (150°F).
- D. Finished joints shall not deviate more than one-quarter (1/4) inch in the horizontal alignment from a straight line.
- E. Any localized humps and or depressions greater than one-quarter (1/4) inch shall require removal and replacement of the WORK in question at CONTRACTORS expense
- F. No ponding of water greater than three-eighths (3/8) inch shall be allowed.
- G. Combination curb, gutter and walk and/or vertical curb and gutter flowline depth shall not vary from adopted standards by more than +/- one-half (1/2) inch, measured vertically from the top of curb to the gutter invert.
- H. Pedestrian walks shall have a minimum of two percent (2.0%) and a maximum of two and one half percent (2.5%) slope toward the roadway.
- I. Heave or settlement of sidewalk, relative to separate curb pour, greater than one-half (1/2) inch shall be cause for corrective action. This provision shall not apply to transverse sidewalk joints.

3.10 QUALITY CONTROL

- A. Testing: Concrete testing and testing laboratory services required shall conform to the following unless otherwise determined by ENGINEER.

Section Type of Test	Project Acceptance Frequency	Point of Sampling Acceptance	Procedures	
			Test Sampling	Project Testing
Sidewalks (Concrete Aggregate Gradation)	1/1000 square yards or fraction thereof for each size aggregate of concrete placed	Stockpile, Belt or Bin	CDOT CP30	CDOT CP31A
Curbing (Concrete Aggregate Gradation)	1/2000 lineal feet or fraction thereof for each size aggregate of concrete placed		CDOT CP30	CDOT CP31A
Moisture Content (Fine Aggregate)	1 per day and as often as needed for quality control		CDOT CP30	CDOT CP60



Section Type of Test	Project Acceptance Frequency	Point of Sampling Acceptance	Procedures	
			Test Sampling	Project Testing
Moisture Content (Coarse Aggregate)	1 per day min. where moisture content is greater than +0.5% from SSD condition	Stockpile, Belt or Bin  The slump, air content, unit weight and compressive strength tests shall be carried out on the first truck of concrete for the daily placement and thereafter in conformance with this table by sampling from the mixer discharge or pumper truck discharge hose	CDOT CP30	CDOT CP60
Slump	1 set of tests for every 1000 square yards or fraction thereof of concrete placed per a day		AASHTO T141	AASHTO T119M/T119
Air Content	1 set of tests for every 1000 square yards or fraction thereof of concrete placed per a day		AASHTO T141 T199	AASHTO T152
Yield and Cement	4 tests for every 2000 lineal feet or fraction thereof of concrete placed per a day		AASHTO T141	AASHTO T121M/T121
Compressive (Sidewalks)	1 set (4) of cylinders per 1000 square yards or fraction thereof of concrete placed per day		AASHTO T141 T23	AASHTO T22
Compressive (Curbing)	1 set (4) of cylinders per 2000 lineal feet or fraction thereof of concrete placed per day		AASHTO T141 T23	AASHTO T22

**B. Repair:**

1. Prior to backfilling and after forms are removed, honeycombed, defective or damaged areas of concrete shall be repaired. Repairs shall be made within seven (7) days after the forms are removed.
2. At the time of final acceptance inspection, the repair of all cracks shall be completed.
  - a. Cracks that are less than one-quarter (1/4) inch wide, exhibit no horizontal or vertical shifting, and do not meet the conditions in 2, 3, and 4, below may, at the discretion of the OWNER, be sealed by routing approximately three-quarter (3/4) inch to one (1) inch deep by one-quarter (1/4) inch wide and filling with Sikaflex 1-A or equivalent.
  - b. Any crack that extends through a joint shall require removal and replacement of the entire cracked area.
  - c. Any longitudinal cracked section of concrete shall require complete removal and replacement of that section between joints.



- d. Repair action for hairline cracks as determined in 1, above, may be waived at the discretion of OWNER. For the purpose of this section, a hairline crack is one that is reasonably immeasurable and without separation as determined by ENGINEER.

### 3.11 CLEAN-UP

- A. The surface of the concrete shall be thoroughly cleaned upon completion of the WORK and prior to the substantial completion walk through, and the site left in a neat and orderly condition.

**END OF SECTION**



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