

**DIVISION 3 – CONCRETE AND PAVEMENT****SECTION 03000 – CONCRETE****1. GENERAL PROVISIONS****1.01. General**

Concrete work within any street, park, trail or alley. Town owned easement of right of way or in any part of the water system, wastewater system, parks, and storm drainage system of the Town shall meet the requirements of these Standards and Specifications. This includes any work being performed directly for the Town or any work being performed for which the Town will have ownership or maintenance responsibilities as well as work within Town controlled property. Engineering, plans, licenses, permits, inspections, warranties and acceptance shall be as detailed in these applicable Standards and Specifications for the type of construction involved.

For all concrete work, where CDOT standards address issues not covered below or are more stringent than those contained herein, CDOT requirements shall be met.

Refer to the General Requirements of these Standards for Abbreviations and Definitions.

**1.02. Reference Documents**

CDOT Standards shall refer to the most recent version of the CDOT Standard Specifications for Road and Bridge Construction, and CDOT Standard plans (M and S Standards).

**1.03. Submittals and Method Statements****A. Design Mix**

Prior to the placement of any concrete the Responsible Party shall provide a design mix for review and approval by the Town. Once approved that will be the only mix to be used on the project. Additional mixes or changes to the mix requires resubmittal and approval of the new mix.

**B. Concrete Proportioning**

Proportioning the "dry" constituents of concrete mixtures shall be accomplished by weighing. The Supplier for the Responsible Party shall provide adequate and accurate scales for this work. The accuracy and tolerances of all scales shall be as prescribed by state law. The scales shall be sealed by the measurement standards section of the Colorado Department of Agriculture at least once each year, each time the scales are relocated, and as often as the Town deems necessary. Weighers certified by the measurement standards section of the Colorado Department of Agriculture shall operate scales. The certified weigher shall perform the duties according to the Colorado Department of Agriculture's regulations. There shall be no variance permitted in the minimum cement factor (sacks per cubic yard) as specified for the mix design. The total quantity of mixing-water per sack of cement, including free water in the aggregates, shall not exceed the maximum specified herein. The Responsible Party shall develop the proper proportions of aggregates, cement and water that shall meet or exceed minimum requirements of these Standards and Specifications. Mix design shall be submitted to the Town, along with at least two (2) sets of 3 certified twenty-eight (28) day

compressive strength test results of the mix proposed for use, for review and approval. No concrete shall be incorporated into the work until the Town approves the concrete mix.

The concrete shall have a compressive strength of not less than four five hundred (4,500) pounds per square inch at twenty-eighth (28th) day after pouring. The minimum cement content of this concrete shall be six (6) standard 94-pound sacks of cement per cubic yard of concrete. The water-cement ratio shall not exceed 0.40, including moisture in aggregates and water added in field adjustments, for watertight structures nor exceed 0.43 for other work. Slump shall not exceed 4" when the middle third of the truck as tested. If greater slump is required (and approved in writing by the Engineer), additional water may be added with a proportional increase in cement to maintain the same water-cement ratio or the use of water reducing agents may be proposed, with sufficient support data, for review and approval by Engineer. Entrained air shall be between 5% - 8 %. Where concrete is to be subject to traffic or other loads in less than 10 days, concrete mix shall be designed to achieve a laboratory compressive strength of at least thirty six hundred (3,600) psi in 72 hours. During hot or cold weather or if the Responsible Party wishes to open the concrete to traffic or load in less than 7 days, additional cylinders shall be formed and those cylinders left on site and cured in the same conditions as the concrete is cured until the day of testing. For flatwork, a CDOT D mix is acceptable as long as the design mix test results include the same admixtures as the concrete furnished.

C. Reinforcement

Submit shop drawings of the reinforcement for Town review. The Town's review of shop drawings and bar schedules shall not relieve the Responsible Party of fulfilling his responsibilities as outlined in the plans and specifications and ensuring that the shop drawings are consistent with the plans and design intent.

D. Method Statements

Provide Method Statements for any processes for which the Town requests.

**1.04. Quality control**

Quality control testing to confirm the concrete meets the Town Standards including air, slump, temperature, and yield, shall be performed on all trucks with the samples taken in the middle 1/3 of the delivery. A minimum of 5 compressive strength cylinders shall be taken for every day of pour from a truck selected by the Town. If more than 35 cubic yards is placed in a single day, compressive strength cylinders shall be taken for each 35 cy or fraction of that placed in a single day. During hot or cold weather or if the Responsible Party wishes to open the concrete to traffic in less than 7 days, additional cylinders shall be formed and those cylinders left on site and cured in the same conditions as the concrete is cured until the day of testing.

If water is added at the job site, slump tests shall be run and test cylinders cast following the addition of the water.

The Responsible Party is encouraged to test the concrete air and slump in advance of placing any concrete to ensure that the material is within specification; however, that testing is not a substitute for the quality control testing required above which must be collected from the middle third of the truck.

The required testing services shall be performed by a testing agency approved by the Town, and testing agencies shall meet the requirements of ASTM E329. A representative of a qualified testing agency shall inspect, sample, and test material and production of concrete as required by the Town at the Responsible

Party's expense. When it appears to the testing representative that any material furnished or work performed by the Responsible Party fails to meet minimum specification requirements, the testing agency shall promptly report the deficiency to the Town and the Responsible Party.

The testing agency shall report test and inspection results to the Town and Responsible Party immediately after they are performed. Test reports shall include the exact location of the work at which the batch represented by a test was deposited. The report of the strength test shall include detailed information on storage and curing of specimen prior to testing, the project number, and the location of the concrete (curb, manhole, inlet, sidewalk, paving, etc.). Test reports shall bear the seal and signature of a PE registered in the State of Colorado and competent in the field of concrete testing. Reports not properly certified shall not be accepted.

The testing agency or its representative is not authorized to revoke, alter, relax, enlarge or release any requirements of these Standards and Specifications, nor approve or accept any portion of the work.

All submittal testing, quality assurance, and quality control testing and reporting costs shall be paid for and scheduled by the Responsible Party.

## **2. MATERIALS**

### **2.01. General**

Concrete shall be composed of Portland cement, aggregate, and water, and shall be reinforced with steel bars, steel wire fabric or fibrous reinforcing where required. No admixture other than air-entraining agents, or water reducing agents shall be used without written permission from the Town and those admixtures shall be the same as used in the concrete for which the supplier provides test results.

### **2.02. Cement**

Cement used in concrete work will be Portland cement conforming to the requirements of ASTM C-150, Type I, IA, Type I/II modified, II, Type V, or IIA. In general, Type II or IIA shall be used in concrete which shall be in contact with the soil, unless otherwise allowed or directed by the Town. Cement that for any reason has become partially set or that contains lumps of caked cement shall be rejected. When preparing the mix design, the Responsible Party shall provide for protection against sulfate attack. By reference the section 601.04 and referenced Table 601-2 of the CDOT Specifications is incorporated. Consideration must also be given to the soils and water with which the concrete may come in contact as well as the aggregates in the mix.

The Supplier for the Responsible Party shall ensure the proper storage of cement until it is used. No damaged cement shall be used in the work, and such cement shall be immediately removed from the site when so ordered by the Town. When requested by the Town, the Responsible Party shall, at his own cost and expense, furnish a certificate from an acceptable testing laboratory for each batch of cement from which cement is taken for use in the work, stating that the cement meets the requirements of these Standards and Specifications for Portland cement.

### **2.03. Flyash**

Approved fly ash may be substituted for ASTM C150 cement up to a maximum of 20 percent Class C or 20 percent Class F by weight of total cementitious material. Percentage shall be calculated as follows:

(Flyash lbs / (Cement lbs + Flyash lbs))

#### 2.04. Aggregates

Aggregates from different sources and of different gradings shall not be stockpiled together. The test results for the mix design shall utilize the same aggregates as will be furnished to the project.

Aggregate shall be handled from stockpiles or other sources to the batching plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. If aggregates contain high or non-uniform moisture content, a storage or stockpile period in excess of 12 hours may be required.

##### A. Coarse Gravels

Coarse aggregate shall conform to the grading in Table 703-1 of the CDOT Standards. Number 57 and Number 67 shall each be furnished in two separate sizes and combined in the plant in the proportions necessary to conform to the grading requirements. Compliance with grading requirements will be based on the combination and not on each individual stockpile.

##### B. Fine Aggregate

Fine aggregate for concrete shall conform with CDOT requirements in Section 703 and Colorado Procedure 31, Method D, unless otherwise specified. The minimum sand equivalent, as tested in accordance with AASHTO T 176 shall be 80 unless otherwise specified. The fineness modulus as determined by AASHTO T 27, shall not be less than 2.50 or greater than 3.50 unless otherwise approved.

#### 2.05. Water

Water for concrete shall be clean and free from sand, oil, salt, acid, alkali, organic matter, or other deleterious substances. Water not from a potable source must be tested in accordance with and meet the suggested requirements of AASHTO T 26. Potable water from public supplies or water which has been proven to be suitable for drinking is preferred and does not need to be tested.

#### 2.06. Air Entrainment

Air entraining admixtures for concrete that will have exposed surfaces shall conform to the requirements of AASHTO M 154. Air-entraining admixtures shall conform to the requirements of ASTM C-260. Admixtures which have been frozen will be rejected. Air content shall be between 5% and 8%. At acceptance testing if the air content is below 5% the Responsible Party can authorize additional air entraining admixture. The mix must then be mixed at mixing speed a minimum of 20 revolutions and re-tested to confirm the adjustment prior to discharging. Delivery of a mixture in excess of 8% will be rejected.

#### 2.07. Admixtures

The Responsible Party may elect to use another admixture provided the Town specifically approves the admixture. Admixtures to be used for plasticizing, densifying, retarding, or acceleration of hardening of concrete shall, when added to the mixture, produce a concrete of the specified strengths in seven (7) day and

twenty-eight (28) day tests. Documented evidence of acceptability shall be required when new or unknown admixtures are proposed for use.

#### **2.08. Flowfill Specifications**

Flow-fill shall meet the requirements of Section 206.02(a) of the current CDOT Standard Specifications for Road and Bridge Construction. Flow fill may be made from different ingredients and/or at different proportions than those specified in the CDOT Standard Specifications when approved by the Town.

#### **2.09. Reinforcement**

##### **A. Fiber Reinforcement**

Fibrous reinforcing shall be used in Portland cement concrete used for curb, gutter, sidewalks, curb turn fillets, cross pans, and valley pans. Note that valley pans wider than 4' also require wire mesh. Fibrous concrete reinforcement shall consist of one hundred (100) percent virgin polypropylene fibrillated fibers specifically manufactured for use as concrete reinforcement, containing no reprocessed olefin materials. Substitutions may be considered at the discretion of the Town. The following shall be submitted to the Town during the submittal process:

- i. One copy of manufacturer's printed product data, clearly marked, indicating proposed fibrous concrete reinforcement materials. Quantity of fiber added should be consistent with manufacturer's recommendation and the proposed use.
- ii. One (1) copy of manufacturer's printed batching and mixing instructions.
- iii. One copy of a certificate prepared by the concrete supplier stating that the approved fibrous concrete reinforcement materials at the rate of one and one-half (1.5) pounds per cubic yard were added to each batch of concrete delivered to the project site. Each certificate shall be accompanied by one (1) copy of each batch delivery ticket indicating the amount of fibrous concrete reinforcement material added to each batch of concrete.

##### **B. Steel Reinforcement**

Steel reinforcement bars shall conform to Standard Specifications for Concrete Steel Reinforcing Bars, Designation A-615, Grade 60, and A-305, of ASTM. Deformations of reinforcing steel bars shall comply with the latest revision of ASTM A 305. All rebar in structures that could potential contain water or sewage shall be epoxy coated. The use of cold twisted bars will not be permitted.

##### **C. Welded Wire**

Welded wire fabric (WWF) for concrete reinforcement shall be of the gauge, spacing, dimensions, and form specified on the plans or detailed drawings and shall comply with "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement" (ASTM A-185) or "Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement" (ASTM A-497). Welded wire fabric shall be adequately supported and in no case will WWF smaller than 6X6/4X4 be used.

#### **2.10. Snap Ties**

Snap ties shall all be cone style and in all work that may need to be water tight have a neoprene waterstop at center of the tie.

**2.11. Water Stop**

Waterstop shall be extruded multi-rib elastomeric PVC as manufactured by Waterseals Inc, Chicago, IL, Greenstreak Plastic Products, St Louis, MO or equal. Unless otherwise specified the water stop shall be 6-inch.

**2.12. Expansion Joint Material**

Expansion joint material shall be non-extruding preformed joint filler and shall conform to ASTM Specification D1751 or D1752.

**2.13. Curing Compound**

Membrane curing compounds for concrete shall be the pigmented type conforming to the requirements of AASHTO-M-148 and/or ASTM-C-309. The type of membrane curing compound chosen shall not permanently discolor the concrete surface.

**2.14. Concrete Sealer**

Sealer shall be a 40% silane penetrating sealer that chemically reacts with and bonds with the concrete substrate such as Dayton J29 or approved equal.

**3. EXECUTION****3.01. Subgrade Preparation**

The subgrade shall be excavated or filled to the required grades and lines as specified below:

- A. Soft, yielding, or otherwise unsuitable material shall be removed and replaced with suitable material to provide a stabilize, dense, compacted base.
- B. Where excavation is needed, the area should be excavated to the elevation designated for the bottom of the structural aggregate fill. It shall then be scarified to a minimum depth of 8", moisture conditioned and compacted to 95% standard proctor at +/- 2% optimum moisture, tested and proof rolled. Aggregate shall then be placed in lifts each compacted to 95% modified proctor at +/- 2% optimum moisture, tested and proof rolled.
- C. Where fill is needed to reach sub base elevation, prior to fill, the area shall be scarified a minimum of 8", moisture conditioned to +/-2% of optimum moisture, and compacted to 95% standard proctor. The fill shall then be placed in maximum 8" lifts with materials specified on the Town approved plans, and each 8" shall be compacted to 95% modified proctor at +/- 2% optimum moisture, tested, and proof rolled.
- D. Prepared area including the aggregate layers shall extend a minimum of 6" outside the line of the forms.
- E. Prior to forming trim class 6 as needed to provide a uniform surface at the correct elevation. Subgrade preparation supporting concrete shall not exceed 1/4" from true line and grade.

**3.02. Forming**

- A. Forms shall be of suitable material and of type, size, shape, quality, and strength to enable construction as designed. The forms shall be set true to line and grade, mortar tight, and sufficiently rigid to resist any appreciable (visible to the eye) amount of springing out of shape during placing of concrete. The responsibility for the adequacy shall rest with the Contractor.
- B. All dirt, chips, sawdust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free of irregularities, dents, sags, and holes that would appreciably deface the finished surface. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused, and the reuse of forms shall be subject to approval of the Engineer.
- C. Wood forms shall be straight and solid, free of warps and cracks. Butt end splices shall be backed to ensure continuous straight forming throughout the full depth of the splice.
- D. Plywood forms, plastic coated plywood forms, or steel forms shall be used for surfaces requiring forming which are exposed to view, whether inside or outside any structure. Surfaces against backfilled earth, interior surfaces of covered channels, or other places permanently obscured from view, may be formed with forms having sub-standard surfaces.
- E. Form snap ties, clamps, or bolts shall be used to fasten forms. The use of twisted wire loop ties to hold forms in position will not be permitted, nor shall wooden spreaders be used unless approved by the Town. Clamps or bolts shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back one (1) inch below the finished surface of the concrete (cone shape only) and in watertight applications should have a waterstop on the snap tie. A two (2) inch clearance shall be provided between snap ties and any rebar. Rebar shall not be supported on the snap ties.
- F. Forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales, all based on the rate of concrete pour.
- G. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent that will leave no objectionable film on the surface of forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete.
- H. Unless otherwise designated on the plans, all exposed edges shall have a 3/4 inch chamfer. Forms for curved surfaces shall be so constructed and placed that the finished surface will not deviate appreciably from the arc of the curve.
- I. Forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of form to remain.
- J. Forms shall not be disturbed until the concrete has cured sufficiently to permit their removal without damaging the concrete or until the forms are not required to protect the concrete from mechanical damage. Minimum time before removal of forms after placing concrete shall be one (1) day for footings and Class "D" concrete and two (2) days for other concrete except in curbs, gutters, sidewalks and pavements. The use of slip forms and concrete paving machines is encouraged.

- K. When requested by the Town, the Responsible Party shall demonstrate by measurements in the presence of the Town that the forms are accurately placed to line and grade and all clearances are in accordance with the plans and specifications. This inspection shall be performed in advance of ordering concrete so as to allow time for corrections if necessary.

**3.03. Slip Form**

Slip form equipment shall be provided with traveling side and top forms of suitable dimensions, shape, and strength to support the concrete for sufficient time during placement to produce the required cross section for the work. The equipment shall spread, consolidate, and screed the freshly placed concrete in such a manner as to provide a dense homogeneous product.

The slip form equipment shall have automatic sensor controls which operate from an offset control line. The line and grade of the slip form equipment shall be automatically controlled.

**3.04. Reinforcement**

Before being positioned, reinforcing steel shall be thoroughly cleaned of mill and rust scale and of coatings that will destroy or reduce the bond. Where there is delay in depositing concrete, reinforcement shall be re-inspected and, if necessary, cleaned. Reinforcement shall be carefully formed to the dimensions indicated on the plans by the cold bending method. Cold bends shall be made around a pin having a diameter of six (6) or more times the diameter of the reinforcing bars. Reinforcement shall not be bent and then straightened. Bars with kinks or bends not shown on the plans shall not be used. Precast mortar blocks, or other non-metal supports shall be as approved by ACI.

**3.05. Concrete Mixing**

**A. Plant Mixed**

Batching and mixing shall be in accordance with ASTM C94, Specifications for Ready Mixed Concrete and CDOT Section 412. Site mixed concrete will not be accepted except for volumes of less than 1/2 cubic yard. The concrete shall be uniform in composition and consistency throughout the mixed batch, and from batch to batch, except where changes in composition or consistency are directed. Concrete shall be continuously mixed or agitated from the time the water is added until the time of use. The stationary mixing (prior to adding water) time shall be between 50-90 seconds. Excessive overmixing requiring the addition of water to preserve the required consistency will not be permitted. The temperature of the concrete when it is being placed shall be not more the 85° F and not less than 40° F in moderate weather, or 50° F when the mean daily temperature drops below 40° F. From the time water is added to the mix or cement comes in contact with aggregate, until the concrete is deposited in place, time shall not exceed 45 minutes if hauled in non-agitating trucks, and 90 minutes if hauled in agitating or mixing trucks.

The Town shall have free access to the mixing plant during times of operation. The organization supplying the concrete shall have sufficient plant and transportation facilities to assure continuous delivery of the concrete at the required rate.

The Responsible Party shall collect batch tickets from the driver for concrete used on the project and deliver them to the Town before discharge.



When the truck arrives at the project site the truck must be mixed at mixing speed for 70 to 100 revolutions. The initial testing of the mix is performed (air content, slump, and temperature) after such mixing. Should there be a need to adjust slump or air content, the mix may be modified in the field with concurrence from the Town to adjust water content (not exceeding the specified water/cement ratio), air content, and chemical modifiers to either delay or accelerate set. The mix should then be mixed in the drum at mixing speed for a minimum of an additional 30 rotations and retested to confirm the adjustments. After initial acceptance testing and before any concrete is placed and through the duration of the discharge of the mix no additional modifications can be made to the mix.

The use of ready-mixed concrete in no way relieves the Responsible Party of proper proportion, mix, delivery, or placement of concrete; concrete must conform to the requirements of these Standards and Specifications and ASTM C-94.

**B. Site Mixed**

Concrete mixed on site (1/2 cy or less) shall be mixed in a drum type mixer which shall conform to the standards of Volumetric Mixer Manufacturer Bureau. The mixer shall be capable of combining the aggregate, cement, and water into a thoroughly mixed and uniform mass and discharging the material without segregation. Concrete shall be thoroughly mixed for a period of not less than two (2) minutes after the materials, including the water, have been placed in the drum. During the mixing period, the drum shall be operated at the speed specified by the manufacturer of the equipment. The entire contents of the mixer shall be discharged before recharge, and the mixer shall be cleaned frequently. The concrete shall be mixed only in quantities that are required for immediate use. The volume of the mixed materials per batch shall not exceed the manufacturer's rated capacity of the mixer. Mixer must be kept clean of hardened concrete.

When concrete is mixed at the site, cement must be Type IA or IIA. The addition of any admixture at the job is prohibited, except where approved by the Town representative. Job mixed concrete must meet the same quality specifications as plant mixed concrete.

On site mixing of concrete other than in a drum is prohibited.

**3.06. Concrete Delivery**

**A. Batch tickets shall provide the following information:**

- i. weight and type of cement;
- ii. weights of fine and coarse aggregates;
- iii. volume (in gallons) of water including surface water on aggregates;
- iv. quantity (cubic yards) per batch;
- v. times of batching and discharging of concrete;
- vi. name of batch plant;
- vii. name of Responsible Party;
- viii. name and amount of admixture if approved; and,
- ix. date and truck number.

- B. Additional field information shall be provided as follows:
- i. time of batch arrival;
  - ii. any modifications to the mix at acceptance and prior to discharge such as gallons of water added;
  - iii. time of discharge;
  - iv. temperature of discharge mix;
  - v. slump of discharge mix;
  - vi. air content of discharge mix; and,
  - vii. yield of discharge mix.

The consistency of concrete shall be kept uniform for each class of work and shall be checked by means of slump tests or Kelly ball tests. The workability of the concrete shall be determined by the installer but adjusting the workability shall not create a deviation from the design mix specifications. Concrete shall have a consistency such that it can be worked into corners and angles of the forms and around joints, dowels and tie-bars by the construction methods, which are being used without excessive spading, segregation or undue accumulation of water or latent material on the surface.

If, through accident, intention, or error in mixing, concrete fails to conform to the proportions of the approved mix design, such concrete shall not be incorporated in the work but shall be properly disposed of off the project site as waste material at the Responsible Party's expense.

### **3.07. Placement**

- A. Before depositing concrete, debris shall be removed from the space to be occupied by the concrete, and the forms, including any existing concrete surfaces, shall be thoroughly wetted. Concrete shall not be placed until forms and reinforcing steel have been inspected by the responsible party in the presence of the Town. Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods that prevent separation or loss of ingredients. The concrete shall be deposited in the forms as nearly as practical in its final position to avoid re-handling. It shall be deposited in continuous layers, the thickness of which generally shall not exceed twelve (12) inches. Concrete shall be placed in a manner that shall avoid segregation and shall not be dropped freely more than five (5) feet. If segregation occurs, the Town may require the concrete to be removed and replaced at the Responsible Party's expense.
- B. Concrete shall be placed in one continuous operation, except where keyed construction joints are shown on the plans or as approved by the Town. Delays in excess of thirty (30) minutes may require removal and replacement of that pour, as determined by the Town. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the ends of projecting reinforcement.
- C. Pipes, fittings, chutes, troughs, spouts, or tremies that are fabricated of aluminum materials for pumping, conveying, or placing concrete shall not be used.
- D. Concrete, except for cofferdam seals, shall not be deposited under water, unless approved by the Town. If approved, care shall be exercised to prevent the formation of laitance. Concrete shall not be

deposited until all laitance, which may have formed on concrete previously placed, has been removed.

- E. Pumping shall be discontinued while depositing foundation concrete if it results in a flow of water inside the forms. If concrete, except for cofferdam seals, is deposited under water, the proportion of cement used shall be increased at least 25 percent at the Responsible Party's expense.
- F. No re-tempering of concrete shall be permitted. Hand-mixed concrete shall not be permitted except by written approval of the Town, and then in only small quantities or in case of an emergency. If the work requires more than ½ cubic yard shall be batched at a ready mix plant.
- G. Placement of form stakes in the concrete should be avoided. Where such placement cannot be avoided, form stakes shall be removed as soon as the concrete is hardened sufficiently to not require the staking. Holes left when the stakes are removed shall be packed full depth with concrete and not, just finished over the top.

### **3.08. Reinforcement**

- A. Reinforcing steel shall be placed in accordance with the approved plans and ACI requirements and shall be accurately placed and secured against displacement by using annealed iron wire no thinner than No. 18 gauge, or by suitable clips at intersections. Where necessary, reinforcing steel shall be supported by metal chairs or spacers, precast mortar blocks, or metal hangers. Splicing of bars, except where shown on the plans, shall not be permitted without approval of the Town.
- B. Reinforcing steel shall not be supported by form ties. Form ties shall be set so there is at least 2" clear between form ties and reinforcing steel.
- C. Unless otherwise shown on the plans, the minimum clear cover for reinforcing steel shall be the following, which is specified in ACI 30I, Section 5.5. Note that "clear" distance is measured from the edge of the bar closest to the form or earth to the form. Where minimum distances are called out, there is no tolerance for the minimum distance.

### **3.09. Consolidation**

- A. Concrete shall be thoroughly compacted and/or vibrated. Concrete shall be compacted by internal vibration using mechanical vibrating equipment, except that concrete in floor slabs, sidewalks, or curb and gutter, not poured against form linings, shall be either tamped or vibrated. Care shall be taken in vibrating the concrete to vibrate only long enough to bring a continuous film of mortar to the surface. Vibration shall stop before any segregation of the concrete occurs. Mechanical vibrators shall be an approved type as specified in ACI Publication 309, Chapter 5. Vibrators shall not be used to move or spread the concrete.
- B. Any evidence of segregation, the lack of consolidation or over-consolidation shall be regarded as sufficient reason to require the removal of the section involved and its replacement with new concrete at the Responsible Party's expense. The Responsible Party shall remedy any defects in the quality and appearance of the completed work.

### **3.10. Joints**

- A. Transverse joints shall be placed at maximum intervals of ten (10) feet to control random cracking; joints shall be formed, sawed, or tooled to a minimum depth of one-quarter (¼) of the total thickness.

Tooled joints shall not be used in sidewalks. If divider plates are used, the maximum depth of plates shall not be greater than one-half (½) depth at the finished surface and shall be no less than one (1) inch.

- B. Contraction Joint. Joints shall be spaced as follows:
- i. Not more than ten (10) feet nor less than five (5) feet apart in curb and gutter and combination curb-sidewalk.
  - ii. Not more than the width of the sidewalk (up to eight (8) feet), nor less than five (5) feet apart in sidewalk.
  - iii. At least two (2) joints, equally spaced at not greater than ten (10) foot intervals applicable in driveways.
  - iv. Around all valves, manholes.
  - v. Should be placed to avoid a joint having a point.
  - vi. As directed by the Town.
- C. Expansion Joints. Expansion joint material shall be provided at the following locations and shall be in place in the forms prior to the placement of concrete:
- i. At each end of curb return.
  - ii. At both edges of driveway.
  - iii. Between back of sidewalk and driveway slab or service walk.
  - iv. Between new concrete and existing - buildings.
  - v. As shown on the drawings.
  - vi. As directed by the Town.
  - vii. Between new and existing concrete. Note: existing concrete is any concrete one day or more old.
  - viii. Every one hundred (100) feet in sidewalk curb and gutter when hand-formed.
  - ix. Every two hundred (200) feet in sidewalk, curb and gutter when placed slip formed.
  - x. Inlets.
- D. Dowel Joints. When new concrete to be placed against existing, the work shall be accomplished so that there is no abrupt change in grade between the old section and the new work. Smooth dowels and full depth expansion material shall be placed between the new and old concrete. Install caulk over the joint once the concrete has cured. Where new sidewalk construction abuts existing sidewalks, no addition to existing sidewalks or other flat work concrete shall be made less than four (4) feet in width.

### 3.11. Finishing

- A. Concrete shall be placed and finished under the direct supervision of an individual with a current ACI Concrete Flatwork Technician certification, or approved equal. Exposed faces of curbs and sidewalks shall be finished to true-line and grade as shown on the plans. After the water has stopped bleeding

and the water sheen has left the surface, the surface shall be floated to a smooth but not slippery finish. Sidewalk and curb shall be broomed or combed and edged, unless otherwise directed by the Town. Before concrete has taken its initial set, edges in contact with the forms shall be tooled with an edger having a three-eighth ( $\frac{3}{8}$ ) inch radius.

- B. No dusting or topping of the surface or sprinkling with water to facilitate finishing shall be permitted. Should there need to be assistance to facilitate finishing, the Responsible Party shall submit a cut sheet for a finishing aid material to the Town for approval. If allowed the finishing aid shall be mixed and applied to the manufacture's recommendation. Application of finishing aid not in accordance with manufacture's recommendation or used in excess will be cause for rejection of the work. Steel trowels shall not be used on air entrained (exterior service) concrete.
- C. Immediately following the removal of the forms, fins and irregular projections shall be removed from surfaces except from those that are not to be exposed or are not to be waterproofed. On surfaces, the cavities produced by form ties, honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, moistened with water and carefully pointed and trued with a mortar consisting of cement and fine aggregate. The surface shall be left sound, of acceptable finish, even, and uniform in color. Mortar used in pointing shall not be more than thirty (30) minutes old.
- D. Construction and expansion joints in the completed work shall be left carefully finished and free of mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

### 3.12. Curing

- A. Fresh concrete shall be protected from weather damage and mechanical injury during the curing periods. The use of a membrane-curing compound is required unless otherwise approved by the Town. The membrane-curing compound shall be applied at the rate of one hundred fifty (150) square feet per gallon unless the manufacturer recommends otherwise and at no less than needed to provide a uniform seal.
- B. Membrane curing compound shall not be used when the concrete surface will be painted.
- C. The selected curing process shall be started as soon as possible without injury to the concrete surface. The following curing procedures may be used subject to the approval of the Town if something other than membrane curing is desired:
  - i. Ponding (for slabs or footings)
  - ii. Wet burlap, earth, or cotton mats
  - iii. Waterproof paper or polyethylene plastic cover
- D. Surfaces being wetted by ponding, spraying, or wetted material shall be kept completely wetted, with an excess of free water on the surface, for the first 120 hours. After this period, for the next 3 days, a wetting schedule shall be followed whereby the concrete is wetted on a schedule approved by the Town.
- E. Surfaces being protected by waterproof paper or polyethylene plastic cover shall receive special attention during the first 120 hours to ensure there is actually free moisture on the surface of the concrete under the waterproof surface and ensure no damaging or discoloring to the surface of the concrete. The Town may require the removal of the cover and a wetting of the surface when, in its

judgment, there is insufficient moisture for curing. After the first 120 hours, the cover shall be kept tightly in place for the remainder of the curing period.

### 3.13. Finishing

Flatwork shall have a light broom finish.

Formed concrete shall conform to CDOT 6014.14 Finishing Hardened Concrete Surfaces. For surfaces below grade, the Class 1 Ordinary Surface Finish will be required. For surfaces above grade, the Class 2 Rubbed Finish shall be required. When specified in the approved plans, Structural Concrete Coating shall be performed.

### 3.14. Cold Weather

- A. During cold weather concreting conditions, concrete construction shall be accomplished in accordance with ACI 306. In all cases, the concrete supplier shall furnish concrete suitable for placement in cold weather conditions. At a minimum cold weather procedures shall be followed when:
- i. A period when more than three successive days the average daily outdoor temperature is below forty degrees (40°) F (the average of the highest and lowest temperatures from midnight to midnight).
  - ii. November, December, January, February, and March regardless of temperature.
- B. The following prohibitions and conditions shall be in effect during cold weather:
- i. The mixed concrete temperature shall be between 50 and 85°F at the time of placement. Water, aggregates, or both shall be heated when necessary under such control and in sufficient quantities to avoid fluctuations in the temperature of the concrete of more than 10° from batch to batch.
  - ii. To avoid the possibility of flash set when the water is heated to a temperature exceeding 100°F, the water and the aggregates shall be charged into the mixer before the cement is added.
  - iii. Heating equipment or methods that alter or prevent the entrainment of the required amount of air in the concrete shall not be used. Equipment used shall be capable of heating the materials uniformly. Aggregates and water used for mixing shall not be heated to a temperature exceeding 125 °F.
  - iv. Materials containing frost or lumps of frozen materials shall not be used.
  - v. Stockpiled aggregates may be heated by use of dry heat or steam. Aggregates shall not be heated by gas or oil flame or on sheet metal over fire.
  - vi. When aggregates are heated in bins, steam-coil or water coil heating, or other methods that will not be detrimental to the aggregates may be used.
  - vii. Concrete shall not be placed on a surface with a temperature of less than 40 F.
  - viii. Before concrete placement, all ice, snow, and frost shall be completely removed.
  - ix. Insulating materials shall be available and easily accessible.

- x. Avoid direct contact of fresh concrete with carbon dioxide emitted from poorly ventilated space heaters.
- xi. Always use ASTM-approved curing compounds to ensure proper curing and to prevent rapid drying and loss of moisture.
- xii. If the concrete is found to have frozen in the first 48 hours, it shall be rejected.

**3.15. Hot Weather**

Except by written authorization of the Town accompanied by an acceptable method statement prepared by Responsible Party to protect the concrete, concrete shall not be placed if the temperature of the plastic concrete cannot be maintained at ninety degrees (90°) Fahrenheit or lower and moisture can be kept in the concrete. The placement of concrete in hot weather shall at a minimum comply with ACI 305.

**3.16. Inclement Weather**

In order that concrete may be properly protected against the effects of rain, hail, or snow before the concrete is sufficiently hardened, the Contractor will be required to have material available at all times for the protection of the edges and surfaces of all unhardened concrete. Such protective material shall consist of material which will protect the surfaces from finish damage or a local shift in water cement ratio. When rain appears imminent, all placement operations shall stop, forms shall be placed against the sides of work and protective covering shall be placed over the surface of the unhardened concrete. Damage caused by inclement weather or vandalism including dimples, changes in the surface water/cement ratio, or damage from protective plastic shall be cause for rejection of the work.

**3.17. Protection of Concrete**

As a minimum, insulated blankets are required as cover for concrete placed during cold weather. It is the responsibility of the Responsible Party, in extreme conditions, to determine if additional measures are needed to meet the temperature requirements.

**3.18. Backfilling**

- A. Backfilling or opening to traffic shall not occur until the concrete has achieved at least 80% of design strength.
- B. Backfilling shall be completed consistent with the requirements of Section 22000 of the Town Standards and the approved plans.
- C. When side forms are removed and the concrete has gained sufficient strength, the space adjoining the concrete shall be promptly backfilled with suitable material, properly compacted, and brought flush with the surface of the concrete and adjoining ground surface.
- D. In embankments, the backfill shall be level with the top of the concrete for at least two (2) feet and then sloped as shown on the drawings or as directed by the Town.

**3.19. Repairs**

- A. After stripping of the forms, if any concrete is found to be not formed as shown on the drawings or is out of alignment or level, or shows a defective surface, segregation, honeycombing, etc., it shall be removed and replaced by the Responsible Party at his expense unless the Town gives written

permission to patch the defective area. In this case, patching shall be done as described in the following paragraphs. Defects that require replacement or repair are those that contain honeycomb, damage due to stripping of forms, loose pieces of concrete, bolt-holes, tie-rod holes, uneven or excessive ridges at form joints, and bulges due to movement of the forms.

- B. Ridges and bulges shall be removed by grinding no more than  $\frac{1}{4}$ ". If in excess of  $\frac{1}{4}$ ", concrete will be rejected, removed and replaced.
- C. Honeycombed and other defective concrete that does not affect the integrity of the structure shall be chipped out, and the vacated areas shall be filled in a manner acceptable to the Town. The repaired area shall be patched with a non-shrink, non-metallic grout with a minimum compressive strength of five thousand (5,000) psi in twenty-eight (28) days. Repair areas treated with an epoxy-bonding agent shall have the approval of the Town before the repair filling is placed.
- D. Bolt-holes, tie-rod holes, and minor imperfections as approved by the Town shall be filled with dry-patching mortar composed of one (1) part Portland cement to two (2) parts of regular concrete sand (volume measurement) and only enough water so that after the ingredients are mixed thoroughly, the mortar shall stick together on being molded. Mortar repairs shall be placed in layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod and bolt holes so that the entire depth of the hole is completely filled with compacted mortar. The mortar mix proportions described above are approximate.
- E. Those areas with excessive deficiencies as determined by the Town shall be removed and replaced at the Responsible Party's expense.
- F. When it is necessary to remove a section of existing sidewalk, the entire plate of concrete between the contraction joints shall be removed unless the amount that needs to be removed is less than 40% of the length of the piece. In addition, no plate less than 5' in length shall be left in place. When removing, all edges of the old sidewalk that are intended remain shall be sawcut to a minimum depth of 1-1/2". If in removing the section to be removed, damage is done to other sections of the concrete, those too shall be removed and replaced.

### **3.20. Defaced, Defective and Damaged Concrete**

It shall be the Responsible Party's responsibility to protect fresh concrete from damage as a result of vandalism, or other cause. Defective concrete, whether damaged or otherwise not consistent with these standards and the design intent shall be removed and replaced at the expense of the Responsible Party.

### **3.21. Sealer**

All concrete flat work shall be sealed. Concrete shall have cured for minimum of 30 days before placing sealer. In preparation for applying the sealer, the concrete shall be throughout cleaned and all curing compound removed. Sealer shall only be applied in strict accordance with manufacturer's recommendations.

### **3.22. Acceptance Requirements**

- A. The acceptance of all concrete improvements by the Town will be based on the following.
  - i. Submittal of all required test results and inspection reports certified by the Engineer or a qualified independent laboratory.



- ii. Confirmation ADA curb ramp measurements, slopes, shapes, function, locations, tolerances, and/or dimension requirements within those defined by Public Right-of-Way Accessibility Guidelines (PROWAG).
- iii. Confirmation that all work has been completed in accordance with these Standards and constructed to the lines and grades within tolerance consistent with the approved plans.
- iv. Tolerances include but are not limited to:
  - (a) Flat surfaces shall not deviate from true line and grade by more than ¼” in 10 ft.
  - (b) Dimensions of formed shapes shall not exceed ¼” from true line and grade.
- v. If exceedances are identified, Responsible Party shall submit a plan to correct the deficiencies for Town review.
- vi. Passing a final inspection of the work by the Town.

**3.23. Penalties for non-conformance**

Table 601-3 Pay Factors in Section 601 of the CDOT Specifications (see below), provides pay reduction factors for deviation from the specified air entrainment, slump, and compressive strength requirements. If in the case of the Town directly contracting the work, the pay reduction factors will be applied to the pay items related to each day of work the test result represents. If in the case the Town is accepting the work the Contractor/Developer is paying for, the Contractor/Developer will pay the Town the amount of the calculated reduction in pay according to table 601-3. When the test results are at a level the table states “Reject”, all concrete work for that day that the test represents is rejected and shall be removed and replaced.

**Table 601-3  
PAY FACTORS**

Percent Total Air		Strength		
Deviations From Specified Air (%)	Pay Factor (%)	Below Specified Strength (psi) [ $< 4500$ psi Concrete]	Pay Factor (%)	Below Specified Strength (psi) [ $\geq 4500$ psi Concrete]
0.0-0.2	98	1-100	98	1-100
0.3-0.4	96	101-200	96	101-200
0.5-0.6	92	201-300	92	201-300
0.7-0.8	84	301-400	84	301-400
0.9-1.0	75	401-500	75	401-500
Over 1.0	Reject	Over 500	Reject	
			65	501-600
			54	601-700
			42	701-800
			29	801-900
			15	901-1000
			Reject	Over 1000

**3.24. Warranty**

The Responsible Party shall guarantee all portions of the work for a period of one year after completion and initial acceptance against defective workmanship and materials and shall keep the work in good repair and comply with the requirements of 20.02 of the General Requirements.

The Town possesses sole authority to require the repair or replacement of dedicated public improvements during the warranty period whose decision upon the matter shall be final and obligatory upon the Responsible Party.