

SECTION 600 - CONCRETE WORK  
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**SECTION 600 - CONCRETE WORK****601 GENERAL PROVISIONS**

This specification enumerates the requirements for the materials, storage, transportation, measuring, mixing, placing, and curing of Portland cement concrete. This specification applies to all Portland cement concrete used in sidewalks, driveways, approaches, patches, manholes, inlets, and other structures constructed in the City of Thornton. Specifications for Portland cement concrete pavement are in Section 500 of these Standards and Specifications. The contractor shall contact the Development Engineering Manager 24 hours in advance of concrete placement when the form work is ready to receive the concrete. Compaction test results shall verify the adequacy of all ground upon which concrete is to be placed.

**602 MATERIALS**

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 shall be used without written permission of the Development Engineering Manager.

**602.1 Cement**

TABLE 600-1  
ALLOWABLE CEMENT FOR USE ON CONCRETE STREETS

| <u>Type</u>  | <u>Specification</u>                    |
|--|---|
| Portland Cement, Type I, II, III<br>Air-Entraining Portland Cement | ASTM C 150, AASHTO M 85<br>AASHTO M 134 |

- A. Cement used in concrete work will be Portland cement conforming to the requirements of Table 600-1. 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 Development Engineering Manager. Cement, which for any reason has become partially set or which contains lumps of caked cement, shall be rejected.
- B. The Responsible Party shall be responsible for 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 Development Engineering Manager. When requested by the Development Engineering Manager, the Responsible Party shall, at his own cost and expense, furnish the Development Engineering Manager with 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.

**602.2 Water**

Water for concrete shall be clean and free from sand, oil, acid, alkali, organic matter, or other deleterious substances. Water from public supplies or water which has been proven to be suitable for drinking is satisfactory.

**602.3 Admixtures**

The Responsible Party shall use air-entraining admixtures for concrete that will have exposed surfaces. The Responsible Party may elect to use another admixture provided the admixture is specifically approved by the Development Engineering Manager. Admixtures to be used for plasticizing, densifying, or acceleration of hardening of concrete shall, when added to the mixture, produce a concrete of specified strength in seven (7) day and 28 day tests. Documented evidence of acceptability shall be required when new or unknown admixtures are proposed for use. Air-entraining admixtures shall conform to the requirements of ASTM C-260.

**602.4 Fine Aggregate**

Fine aggregate shall be composed of clean, hard, durable, uncoated particles of sand, free from injurious amounts of clay, dust, soft or flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves shall meet the Concrete Aggregate Gradation Table 600-2 and shall also conform to AASHTO M6.

**602.5 Coarse Aggregate**

- A. The coarse aggregate shall consist of broken stone or gravel composed of clean, hard, tough and durable stone and shall be free from soft, thin, elongated or laminated pieces, disintegrated stone, clay, loam, organic, or other deleterious matter.

- B. Coarse aggregate shall conform to Number 357 or Number 467 coarse aggregate from the Concrete Aggregate Gradation Table 600-2, which shall also conform to AASHTO M43.

TABLE 600-2  
CONCRETE AGGREGATE GRADATION TABLE  
% PASSING DESIGNATED SIEVES AND NOMINAL SIZE DESIGNATION

| Coarse Aggregates (From AASHTO M 43) |          |                |              |            | Fine Aggregate |          |            |          |              |            |
|--------------------------------------|----------|----------------|--------------|------------|----------------|----------|------------|----------|--------------|------------|
|                                      | No.3     | No.4           | No.6         | No.7       | No.8           | No.57    | No.67      | No.357   | No.467       | AASHTO M 6 |
| Sieve Size                           | 2" to 1" | 1-1/2" to 3/4" | 3/4" to 3/8" | 1/2" to #4 | 3/8" to #8     | 1" to #4 | 3/4" to #4 | 2" to #4 | 1-1/2" to #4 | #4 to #100 |
| 2-1/2"                               | 100      | .....          | .....        | .....      | .....          | .....    | .....      | 100      | .....        | .....      |
| 2"                                   | 90-100   | 100            | .....        | .....      | .....          | .....    | .....      | 95-100   | 100          | 100        |
| 1-1/2"                               | 35-70    | 90-100         | .....        | .....      | .....          | 100      | .....      | .....    | 95-100       | 95-100     |
| 1"                                   | 0-15     | 20-55          | 100          | .....      | .....          | 95-100   | 100        | 35-70    | .....        | .....      |
| 3/4"                                 | .....    | 0-15           | 90-100       | 100        | .....          | .....    | 90-100     | .....    | 35-70        | .....      |
| 1/2"                                 | 0-5      | .....          | 20-55        | 90-100     | 100            | 25-60    | .....      | 10-30    | .....        | .....      |
| 3/8"                                 | .....    | 0-5            | 0-15         | 40-70      | 85-100         | .....    | 20-55      | .....    | 10-30        | 100        |
| #4                                   | .....    | .....          | 0-5          | 0-15       | 10-30          | 0-10     | 0-10       | 0-5      | 0-5          | 95-100     |
| #8                                   | .....    | .....          | .....        | 0-5        | 0-10           | 0-5      | 0-5        | .....    | .....        | 50-100     |
| #16                                  | .....    | .....          | .....        | .....      | 0-5            | .....    | .....      | .....    | .....        | 50-85      |
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| #100                                 | .....    | .....          | .....        | .....      | .....          | .....    | .....      | .....    | .....        | 2-10       |

#### 602.6 Fibrous Reinforcing

- A. Fibrous reinforcing shall be used in Portland cement concrete used for curb, gutter, sidewalks, curb turn fillets, cross pans, and valley gutters.
- B. The following shall be submitted to the Development Engineering Manager:
- One (1) copy of manufacturer's printed product data, clearly marked, indicating proposed fibrous concrete reinforcement materials. Printed data should state one and one-half (1½) lbs of fiber to be added to each cubic yard of each type of concrete.
  - One (1) copy of manufacturer's printed batching and mixing instructions.
  - One (1) 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 (1½) 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 amount of fibrous concrete reinforcement material added to each batch of concrete.
- C. Fibrous concrete reinforcement shall consist of:
- 100% virgin polypropylene fibrillated fibers specifically manufactured for use as concrete reinforcement, containing no reprocessed olefin materials. Fibrous concrete reinforcement shall be as manufactured by Fibermesh Company, Buckeye Ultra Fiber 500, or approved equal.
  - Physical characteristics:
    - Specific gravity = 0.905 grams per cubic centimeter.
    - Tensile strength: 70 to 110 psi.
    - Fibrous concrete reinforcement materials provided by this subsection shall produce concrete conforming to the requirements for each type and class of concrete required as indicated.
    - Construction methods:
      - Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accord with approved submittals for each type of concrete required.
      - Mix batched concrete in strict accord with fibrous concrete reinforcement manufacturer's instructions and recommendations for uniform and complete dispersion.

- e. Concrete placing and finishing: Place and finish concrete materials as specified in subsections 605 and 607.

### 603 MIXING

#### 603.1 General

Concrete shall be thoroughly mixed in a batch mixer of an approved type and capacity for a period of not less than two (2) minutes after the materials, including the water, have been placed in the drum. During the period of mixing, 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 such quantities that are required for immediate use. No retempering of concrete shall be permitted. Hand-mixed concrete shall not be permitted except by written approval of the Development Engineering Manager, and then in only small quantities or in case of an emergency.

#### 603.2 Design of the Mix

##### A. Proportioning

Proportioning the "dry" constituents of concrete mixtures shall be accomplished by weighing. The Responsible Party shall provide adequate and accurate scales for this work. Scales shall be accurate within the allowable tolerances as prescribed by state law. The scales shall be certified 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 engineer may deem necessary. Scales shall be operated by weighers certified by the measurement standards section of the Colorado Department of Agriculture. 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 calls of concrete. 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 be responsible for developing the proper proportions of aggregates, cement and water that shall conform to the various requirements of these Standards and Specifications. Mix design shall be submitted to the City, along with at least two (2) sets of certified 28 day test results, for review and approval. No concrete shall be incorporated into the work until the proportions are approved by the Development Engineering Manager.

##### B. Classification

The classification shall conform to CDOT Standard Specifications Table 601-1 for concrete classes and mix requirements for Class D concrete at 28 days, except that Number 357 or Number 467 shall be used.

#### 603.3 Ready-Mixed Concrete

- A. The use of ready-mixed concrete in no way relieves the Responsible Party of the responsibility for proportion, mix, delivery, or placement of concrete; concrete must conform to the requirements of these Standards and Specifications, ASTM C-94, and AASHTO M 157 .
- B. Concrete shall be continuously mixed or agitated from the time the water is added until the time of use and shall be completely discharged from the truck mixer or truck agitator within one and one-half (1½) hours after it comes in contact with the mixing water or with the aggregates. Retempered concrete shall not be allowed.
- C. The City 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 delivery, or batch, tickets from the driver for concrete used on the project and deliver them to the Development Engineering Manager). Batch tickets shall provide the following information:
  1. Supplier's name and date.
  2. Truck number.
  3. Project number and location.
  4. Concrete class designation.
  5. Cubic yards batched.
  6. Time batched.
  7. DOH mix design number.
  8. Type, brand, and amount of cement and fly ash.
  9. Brand and amount of any admixture.
  10. Weights of fine and coarse aggregates.
  11. Moisture content of fine and coarse aggregates.
  12. Gallons of batch water (including ice).
  13. Gallons of water added by truck operator.

D. Provide the following titles with blank space to record information:

1. Discharge time.
2. Water-cement ratio.
3. Air content.
4. Slump.
5. Revolutions.

#### **604 REINFORCING STEEL AND FORMS**

##### **604.1 Reinforcing Steel**

A. Reinforcing steel shall conform to the requirements of the following specifications:

- |  |              |
|--|--------------|
| 1. Deformed and plain billet-steel bars for concrete reinforcement | AASHTO M 31  |
| 2. Axle-steel deformed and plain bars for concrete reinforcement   | AASHTO M 53  |
| 3. Fabricated steel bar or rod mats for concrete reinforcement     | AASHTO M 54  |
| 4. Welded steel-wire fabric for concrete reinforcement             | AASHTO M 5   |
| 5. Welded deformed steel wire fabric                               | AASHTO M 221 |
| 6. Epoxy coated rebar  | AASHTO M 284 |

B. Unless otherwise designated, bars conforming to AASHTO M 31 and M 53 shall be furnished in Grade 60 for No. 5 bars and larger, and Grade 40 or 60 for bars smaller than No. 5., and all bars shall be epoxy coated. In AASHTO M 54, bar material conforming to AASHTO M 42 will not be permitted.

C. 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 not approved by ACI shall not be allowed to remain in the concrete placement.

D. Reinforcing steel shall be accurately placed and secured against displacement by using annealed iron wire of not less 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 Development Engineering Manager.

E. Welded wire fabric 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-741) or "Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement" (ASTM A-497).

F. Responsible Party shall submit to the City shop drawings of the reinforcement for approval. The Development Engineering Manager's approval of shop drawings and bar schedules shall not relieve the Responsible Party of fulfilling his responsibilities as outlined in the plans and specifications.

G. 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:

1. ☐ Bottom bars on soil bearing foundations and slabs: three (3) inches.
2. Bars adjacent to exposed surfaces or earth backfill:
  - a. For bars more than three-fourths ( $\frac{3}{4}$ ) inch in diameter: two (2) inches.
  - b. For bars three-fourths ( $\frac{3}{4}$ ) inch or less in diameter: one and one-half ( $1\frac{1}{2}$ ) inches.
3. Interior Surfaces: slabs, walls, joints with one and three-eighths ( $1\frac{3}{8}$ ) inch diameter or smaller: three-fourths ( $\frac{3}{4}$ ) inch.

##### **604.2 Forms**

A. Whenever necessary, forms shall be used to confine the concrete and shape it to the required lines. Forms shall have sufficient strength to withstand, without deformation, the pressure resulting from

placement and vibration of the concrete. Forms shall be constructed so that the finished concrete shall conform to the shapes, lines, grades and dimensions indicated on the approved plans. Any form which is not clean and has not had the surface prepared with a commercial form oil that shall effectively prevent bonding and that will not stain or soften concrete surfaces shall not be used.

- B. 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.
- C. Forms shall not be disturbed until the concrete has hardened 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 two (2) days for other concrete except in curbs, gutters, sidewalks and pavements. The use of slip forms and concrete paving machines shall be allowed, with approval of the Development Engineering Manager.

#### 605 PLACING CONCRETE

- A. The subgrade shall be excavated or filled to the required grades and lines. Soft, yielding, or otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted and compaction shall extend a minimum of one (1) foot outside the form lines.
- B. The subgrade shall be compacted to the density shown on the plans and trimmed to provide a uniform surface at the correct elevation.
- C. 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 and approved by the Development Engineering Manager. Concrete shall be handled from the mixer to the place of final deposit as rapidly as possible by methods which prevent separation or loss of ingredients. The concrete shall be deposited in the forms as nearly as practicable in its final position to avoid re-handling. It shall be deposited in continuous layers, the thickness of which generally shall not exceed 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 Development Engineering Manager may require the concrete to be removed and replaced at the Responsible Party's expense. Concrete shall be placed in one continuous operation, except where keyed construction joints are shown on the plans or as approved by the Development Engineering Manager. Delays in excess of 30 minutes may require removal and replacement of that pour, as determined by the Development Engineering Manager.

##### 605.1 Vibrating

- 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 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 be responsible for any defects in the quality and appearance of the completed work.

##### 605.2 Workability

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 varied as directed by the Development Engineering Manager. 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. No water shall be added at the job site without permission of the Development Engineering Manager. If approval is obtained and water is added at the job site, slump tests shall be run and test cylinders cast following the addition of the water. Expenses incurred in excess of ordinary tests shall be borne by the Responsible Party.

## 605.3 Concrete Temperature

At the time of concrete placement, the mix temperature shall be between 50° F and 90° F. In cold weather, aggregates and water may be heated as part of the batching operation but they shall not be heated beyond a temperature of 150° F. Aggregates shall not be heated directly by gas flame or oil flame, or on sheet metal over direct flame. Materials containing frost or lumps of frozen material shall not be used in the mix, and their presence in the concrete shall be cause for rejection of that batch.

**606 JOINTS**

## 606.1 Materials

Joint materials, if permitted, shall conform to AASHTO, ASTM Specifications according to type as follows:

|  | <u>AASHTO</u> | <u>ASTM</u> |
|--|---------------|-------------|
| Concrete joint sealer, hot poured elastic or 888 Corning Cold or approved equivalent | M 173         | D1190-74    |
| Preformed expansion joint filler (Bituminous Type)                                   | M 33          | D994-71     |
| Preformed sponge rubber and cork expansion joint fillers                             | M 153         | D1752-67    |
| Preformed expansion joint fillers -nonextruding and resilient bitumen                | M 213         | D1751-73    |

## 606.2 Spacing

## A. Contraction Joints

Transverse joints shall be placed at maximum intervals of 10 feet to control random cracking; joints shall be formed, sawed, or tooled to a minimum depth of one-fourth (1/4) of the total thickness. If divider plates are used, the maximum depth of plates shall not be greater than one-half (1/2) depth at the finished surface and shall be no less than one (1) inch.

**607 FINISHING AND CURING**

- A. Exposed faces of curbs and sidewalks shall be finished to true-line and grade as shown on the plans. 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 Development Engineering Manager. After completion of brooming and before concrete has taken its initial set, edges in contact with the forms shall be tooled with an edger having a three-eighths (3/8) inch radius. No dusting or topping of the surface or sprinkling with water to facilitate finishing shall be permitted.
- B. Immediately following the removal of the forms, fins and irregular projections shall be removed from surfaces except from those which 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 or removed and replaced at the direction of the Development Engineering Manager. The surface shall be left sound, of acceptable finish, even, and uniform in color. Mortar used in pointing shall not be more than 30 minutes old. Construction and expansion joints in the completed work shall be left carefully tooled and free of mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.
- C. Fresh concrete shall be protected from weather damage and mechanical injury during the curing periods. Curing processes described herein may be used at the option of the Development Engineering Manager. The selected curing process shall be started as soon as it can be done without injury to the concrete surface. The use of a membrane curing compound is required.
- D. Membrane curing compound shall not be used when the concrete surface will be painted. The type of membrane curing compound chosen shall not permanently discolor the concrete surface. Where membrane curing compound is not used, the curing process shall be carefully adhered to as follows in subsection E below.
- E. The following curing procedures may be used subject to the approval of the Development Engineering Manager:
  1. Wet Burlap Curing



After completion of the finishing operations, the surface of the concrete shall be entirely covered with burlap mats. The mats used shall be in such length or width that as laid they will extend at least twice the thickness of the concrete beyond the edges of the slab or structure. They shall be placed so that the entire structure and all edges of the concrete, when forms are removed, are completely covered. This covering shall be placed as soon as the concrete has set sufficiently to prevent marring of the surface. After being placed, the mats shall be thoroughly saturated with water by spraying with a mist spray. The burlap shall be so placed and weighted down so it remains in contact with the surface covered, and the covering shall be maintained fully wetted and in position for seven (7) days after the concrete has been placed. If it becomes necessary to remove the burlap for any reason, the concrete shall not be exposed for a period of more than one-half (1/2) hour. This method of curing shall not be used when the outside air temperature is below 32° F unless heated enclosures are provided.

2. Plastic Sheet Curing

As soon after the completion of the finishing operation, as the concrete has set sufficiently to prevent marring of the surface, the top surface and sides shall be entirely covered with plastic sheet materials. The plastic sheet, as prepared for use, shall have such dimensions that each unit as laid will extend beyond the edges of the concrete at least twice the thickness of the concrete. The units, as used, shall be lapped at least 12 inches, and the laps of plastic sheet shall be secure such that they do not open up or separate. The plastic shall be placed and weighted so it remains in contact with the surface covered, curing the entire curing period of seven (7) days.

3. Waterproof Paper Curing

The procedures used for plastic sheet curing shall be used when waterproof paper is used in curing concrete.

4. Liquid Curing Membrane

Immediately after the surface water has disappeared from the concrete surface, the liquid membrane curing compound (white pigmented) shall be sprayed under pressure to the concrete surface at a rate not less than one (1) gallon per 150 square feet with a spray nozzle, or nozzles, so that it covers the entire pavement with a uniform water-impermeable film. If the forms are removed within seven (7) days, the exposed sides and edges shall be sprayed in the above-described manner or the backfill completed immediately.

5. Insulation Pad

Insulation pads or other thermal devices may be used to protect concrete in cold weather.

6. Wax Base and Resins

Wax base and resin base solutions shall not be used if linseed oil protection is to be applied to the concrete surface. If linseed oil protection is to be utilized, the method of curing shall be either linseed oil base curing compound, wet burlap, plastic sheet, or waterproof paper curing.

**608 PROTECTION**

**608.1 Cold Weather Concreting**

- A. During extreme weather conditions, placing of concrete shall be permitted only when the temperature of the concrete placed in the forms shall not be less than 60° F nor more than 90° F. To maintain this temperature range, the Responsible Party shall provide acceptable heating apparatus for heating the aggregates and the water. Concrete may be placed when the air temperature in the shade is 40° F, and rising. No concrete shall be placed, regardless of the present temperature, when the weather forecast promises freezing weather before final set of the concrete unless special means of heating and protection are used. Protection against freezing is the Responsible Party's responsibility regardless of the weather forecast or climatic conditions at the time of placing.
- B. Small structures and slabs may be protected by completely covering fresh concrete with canvas to a depth that ensures protection. Material shall be secured to prevent displacement by the elements. Large structures or vertical walls shall be protected against freezing by enclosing the structure and heating with salamanders, heaters, or other devices capable of providing uniform and even heat throughout the structure.
- C. Concrete placed in cold weather shall be protected from extreme temperatures as follows:
  1. A temperature of at least 50° F for the first 72 hours shall be maintained.

2. After the first 72 hours and until the concrete is seven (7) days old, it shall be protected from freezing temperatures.
  3. Concrete adjacent to heaters or salamanders shall be insulated from direct heat of the unit which may dry it out prior to being properly cured.
  4. Temperatures shall be measured by maximum and minimum thermometers furnished by the Responsible Party and installed adjacent to the concrete.
- D. Concrete slabs shall not be placed, regardless of temperature conditions, if the supporting ground is frozen or contains frost. Use of salt or other additives to prevent concrete from freezing shall not be allowed. Concrete which has been frozen shall be completely removed and replaced as directed by, and to the satisfaction of, the Development Engineering Manager.

608.2 Hot Weather Concreting

Except by written authorization, concrete shall not be placed if the temperature of the plastic concrete cannot be maintained at below 90° F. The placement of concrete in hot weather shall comply with ACI 305.

**609 MISCELLANEOUS**

609.1 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, it shall be in violation of the requirements set forth in these Standards and Specifications and shall be removed and replaced by the Responsible Party at his expense unless the Development Engineering Manager 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. Ridges and bulges may be removed by grinding upon the approval of the Development Engineering Manager. Honeycombed and other defective concrete that does not affect the integrity of the structure shall be removed and replaced in a manner acceptable to the Development Engineering Manager.
- B. Bolt-holes, tie-rod holes, and minor imperfections as approved by the Development Engineering Manager, 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.
- C. Those areas with excessive deficiencies as determined by the Development Engineering Manager shall be removed and replaced at the Responsible Party's expense. All replacement as required by the Development Engineering Manager shall be full stone replacement, control joint to control joint, with no partial stone replacements allowed. Where repairs are made in existing sidewalks, all edges of the old sidewalk allowed to remain shall be sawcut to a minimum depth of two (2) inches. No rough edges shall be permitted where new construction joins the old section. Rebar doweling shall be required at all construction joints between new construction and the old section. Unless directed by the Development Engineering Manager, no section less than five (5) feet in length shall be placed or left in place. Where new sidewalk construction abuts existing sidewalks, the work shall be accomplished so that there is no abrupt change in grade between the old section and the new work. Concrete replacement adjacent to asphalt roads will require the asphalt be saw cut 18 inches away from the concrete edge to allow for proper forming and placement of concrete. Asphalt patch back will be required as directed by the Development Engineering Manager.
- D. No addition to existing sidewalks or other flat work concrete shall be made less than four (4) feet in width.
- E. Vertical surface discontinuities (i.e. vertical difference in level between two adjacent surfaces) shall be less than .25 inches.

609.2 Cleanup

The exposed surfaces of the concrete shall be thoroughly cleaned upon completion of the work, and the site shall be left in a neat and orderly condition.

## 609.3 Backfilling

- A. 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. 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 Development Engineering Manager.
- B. When the area behind the walk is to be paved, a minimum of four (4) inches of asphaltic surfacing and six (6) inches of base course shall be used and shall be constructed in accordance with these Standards and Specifications. Existing pavement which is damaged during construction shall be repaired by the Responsible Party at his expense. Patching shall match existing asphalt or concrete and shall be the Responsible Party's responsibility.

## 609.4 Testing

## A. General

1. The requirements of this section shall apply to testing services for concrete curb and gutter, sidewalk, pavement, slope paving, retaining walls, structures, and for miscellaneous concrete testing.
2. Concrete materials and operations shall be tested as directed by the Development Engineering Manager and as herein stipulated. The required testing services shall be performed by a testing agency approved by the Development Engineering Manager, and testing agencies shall meet the requirements of ASTM E329.
3. A representative of the testing agency shall inspect, sample, and test material and production of concrete as required by the Development Engineering Manager at the Responsible Party's expense. When it appears that any material furnished or work performed by the Responsible Party fails to fulfill specification requirements, the testing agency shall report such deficiency to the Development Engineering Manager and the Responsible Party.
4. The testing agency shall report test and inspection results to the Development Engineering Manager 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.
5. 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.

## B. Tests Provided by the Responsible Party

The following services shall be performed by the designated testing agency at the expense of the Responsible Party:

1. Conduct strength test of the concrete during construction in accordance with the following procedure: Secure composite samples in accordance with AASHTO T141; mold and cure specimens from each sample in accordance with AASHTO T23. The maximum time between sampling and casting the cylinders or beams shall be 45 minutes. One (1) test series shall be taken per 50 cubic yards (or fraction thereof) of the concrete placed per day, or as directed by the Development Engineering Manager.
  - a. Field cured test series: four (4) cylinders, one (1) to be broken at seven (7) days or as directed by the Development Engineering Manager.
  - b. Lab cured test series: four (4) cylinders one (1) to be broken at seven (7) days; two (2) to be broken at 28 days. One (1) to be held for 56 day break should the 28 day breaks fail.
2. Determine slump of the concrete sample of each strength test whenever consistency of concrete appears to vary, or when directed by the Development Engineering Manager, in accordance with AASHTO T119.
3. Determine air content of the concrete sample for each strength test in accordance with either AASHTO T152 (pressure method), T196 (volumetric method), or T121 (gravimetric method).

4. Sample additional concrete at point of placement, and perform other testing or inspection service as required.
  5. When required by the Development Engineering Manager, the Responsible Party shall provide concrete mix designs, the results of which shall be immediately reported to the Development Engineering Manager. When pumped concrete is to be used, a separate mix design shall be required. Mix designs shall be in accordance with ACI 211 and 304, as applicable.
  6. Additional testing and inspection required because of changes in materials or proportions.
  7. When the work fails to pass inspection or previous tests fail to meet specifications, additional tests shall be taken as directed by the Development Engineering Manager.
  8. Core samples shall be obtained and tested when samples of fresh concrete were not obtained and tested in accordance with the provisions of these Standards and Specifications. Obtaining and testing cores shall be in accordance with ASTM C42. Concrete in the area represented by a core test shall be considered adequate if the average strength of the cores is equal to at least 85% of the specified strength  $f'_c$ , and if no single core is less than 75% of the specified strength. Core holes shall be filled with low slump concrete or mortar.
  9. Failure of the Responsible Party to furnish testing as herein described shall be sufficient cause for rejection of the work in question.
- C. Responsibility and Duties of the Responsible Party
1. The Responsible Party shall provide the testing agency with the following:
    - a. Any labor necessary to assist the designated testing agency in obtaining and handling samples at the project or from other sources of material.
    - b. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test specimens on the project site as required by AASHTO T23.
  2. The use of testing services in no way relieves the Responsible Party of the responsibility to furnish material and construct in full compliance with these Standards and Specifications.

## 610 FLOWCRETE / FLOWFILL CONCRETE

### 610.1 Specifications

The following is the specification of the flowcrete/flowfill concrete as directed by the Development Engineering Manager:

| Mix Proportions: (per cubic yard of concrete) |                    |                  |
|---|--------------------|------------------|
| Material                                      | ASTM Specification | Weight           |
| Cement  | ASTM C-150         | 42 to 50 lbs     |
| Sand  | ASTM C-33          | 1845 to 1850 lbs |
| Aggregate                                     | ASTM C-33          | 1700 to 1750 lbs |
| Air Entrainment                               | ASTM C-260         | 5.0 ounces       |
| Water   | ASTM C-94          | 39 gallons       |

DESIGN PHYSICAL PROPERTIES: Slump shall be six (6) to eight (8) inches

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