SECTION 2000 CONCRETE

2001 SCOPE. This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, and other appurtenant work.

2002 GENERAL.
All cast-in-place concrete shall be accurately formed, and properly placed and finished as shown on the drawings and specified herein. The Contractor shall inform the Engineer at least 24 hours in advance of the times and places at which he intends to place concrete.

2003 MATERIALS.
All material used in the manufacture of concrete shall conform to the following:

A. Concrete Control and Quality. The current editions of the "KCMMB Concrete Material Specification" issued by the Kansas City Metro Materials Board (KCMMB) are made a part hereof by reference. However, when the provisions of such "Bulletins" and "Sections" differ from these specifications, the provisions of this Specification shall govern.

B. Concrete. Concrete for use in construction shall conform to the requirements of Sections 2005 and 2006.

1. Cementitious Materials: The total mass of cementitious materials shall be a minimum of 600 pounds per cubic yard of concrete. Mix designs shall use ASTM C-150 Type I, II, I/II or III Portland Cement. When used, ASTM C595 Type IL cement shall be substituted on a pound for pound basis for Portland Cement.

2. Coarse Aggregate: Coarse Aggregate sources shall meet the requirements of KCMMB specification section 2. Coarse aggregates shall meet the gradation requirements of the current ASTM C33. Mix designs shall specify the gradation designation. Maximum Coarse Aggregate size within mixes shall be as defined within section 2006 of this specification.

   Aggregates in mixes must be proportioned to have a minimum of 55% coarse aggregate by weight.

3. Fine Aggregate and Mixing Water: Fine aggregate shall meet the requirements set forth in the current ASTM C33. The percentage by weight of clay lumps and friable particles shall not exceed 0.25%. The percentage by weight of material passing the no. 200 sieve shall not exceed 2%. The percentage by weight of coal and lignite shall not exceed 0.25%. Soundness shall be determined using magnesium sulfate.

4. Admixtures.
   Concrete mixes approved for use on projects shall include required admixtures in accordance with the currently approved KCMMB mix design. Requests for admixtures listed as optional on specific mix designs shall be

submitted to the Owner and approved by the Owner prior to use on the project. Chemical admixtures shall meet the requirements of ASTM C494. Additionally, any water withheld shall be added to the mix prior to using a superplasticizer.

C. Reinforcing Steel.

1. Bars.
Bars shall conform to ASTM A615, or ASTM A996.

2. Welded Steel Wire.
Welded steel wire fabric shall conform to ASTM A-1064.

3. Supporting Elements.
Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

D. Expansion Joint Fillers.
Expansion joint fillers shall conform to ASTM D-1752-18.

E. Joint Sealing Compounds. Joint sealing compounds shall be single or multicomponent cold-applied elastomeric joint sealant conforming to ASTM C920-18.

F. Curing Membrane.
All material to be used or employed in curing Portland Cement Concrete must be approved by the Engineer prior to its use. It shall be of the liquid membrane type (either white or clear) and shall conform to the either ASTM C309-19 or ASTM C1315-19. Application rate and method are to be as prescribed by the manufacturer for applicable conditions.

2004 PRELIMINARY REVIEW.
A report shall be submitted to the Engineer prior to the placement of concrete and shall include data on proposed concrete mix proportions and the fine and coarse aggregate gradation. Mix proportions shall be selected preferably on the basis of field experience and may be adjusted upon approval of the Engineer where required to produce concrete of proper workability, uniform consistency, and acceptable density and strength.

A tentative concrete mix shall be designed and tested for each size and gradation of aggregate and for each slump intended to be used on the work. Design quantities and test results of each mix shall be submitted to the Engineer for review and approval.

2005 CONCRETE MIX DESIGNATIONS.
The 28-day compressive strength for concrete shall be 5,000 psi and designated as "KCMMB 5K", or shall be 4,000 psi and designated as "KCMMB 4K". Compressive strength shall be determined in accordance with ACI 318. All mix designs shall match an approved mix design by the KCMMB. The mix name shall be listed on the concrete delivery ticket or the concrete will be rejected.
The following tabulation indicates minimum strengths for the various types of concrete mix

designs that will be accepted.

The following indicates minimum strengths for cast-on place or pre-cast applications:

- pavements – KCMMB 4K
- curbs – KCMMB 4K
- curb and gutter – KCMMB 4K
- sidewalks – KCMMB 4K
- drive approaches – KCMMB 4K
- inlets – KCMMB 4K
- manholes – KCMMB 4K
- reinforced concrete boxes – KCMMB 4K
- bridges – as specified by Design Engineer and approved by Owner

Mixes for High Early Strength Concrete shall meet all of the City of Liberty and KCMMB requirements for standard 4K and 5K mixes (designated as "KCMMB HE") as well any additional requirements for High Early Strength Concrete. When high-early strength cement is to be used for concrete, the mix shall obtain a 7-day strength not less than the minimum 28-day strength specified for concrete of the same class.

2006 LIMITING REQUIREMENTS.
Concrete mixes shall meet the following limiting requirements:

- Maximum Slump for Concrete Pavements shall be 2”, (+/-) 1”
- Maximum Slump for Concrete Work other than Pavement shall be 4”, (+/-) 1”
- Maximum Size Coarse Aggregate of 1”

Use of slumps in excess of those specified shall be only when authorized by the Engineer. The use of water to obtain so-called "improved workability" (adding water with a brush to surface, “flipping”) shall not be permitted.

The initial set as determined by ASTM C403 shall be attained 5-1/2 hours, plus or minus one hour, after the water and cement are added to the aggregates. If such use has been approved by the Engineer, the quantity of retarding or accelerating admixture shall be adjusted to compensate for variations in temperature and job conditions.

The total volumetric air content of concrete after placement shall be as prescribed by KCMMB.

Compressive strength shall be determined by ASTM C39.

As the work progresses, the Engineer reserves the right to change the proportions from time to time if conditions warrant such changes to produce a satisfactory job. Any such changes may be made within the limits of the specifications at no additional compensation to the Contractor.

2007 BATCHING AND MIXING.
Concrete shall be furnished by an acceptable ready-mixed concrete supplier and shall conform to KCMMB.

The consistency of concrete shall be suitable for placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded.

The slump shall be kept uniform.

2008 PLACEMENT.
The limits of each concrete pour shall be predetermined by the Contractor and shall be acceptable to the Engineer. All concrete within such limits shall be placed in one continuous operation.

Before concrete is placed, forms, reinforcements, and embedment shall be rigidly secured in proper position and all dirt, mud, water and debris shall be removed from the space to be occupied by the concrete. Bonding surfaces shall be cleaned of all foreign material and shall be free from laitance. Concrete shall not be placed on frozen subgrade or in excavations that have been dewatered.

Placement of concrete shall conform to accepted professional industry and this specification. Concrete shall be placed within forty-five (45) minutes of mixing operations, with the exception that the Engineer may extend the period to ninety (90) minutes (maximum) dependent upon weather conditions. Concrete shall not be placed in horizontal layers exceeding eighteen (18) inches. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcements and embedment and into the corners of the forms. The concrete shall be vibrated or spaded to produce a solid mass without honeycomb or surface air bubbles.

2009 COLD WEATHER CONCRETING.
Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when the descending air temperature in the shade and away from artificial heat reaches 40 degrees F or when forecast to drop below 40 degrees F within 24 hours of placement, and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 degrees F.

When concrete work is authorized during cold weather, the aggregates may be heated by methods approved by the Engineer prior to being placed in the mixer. No ingredient that is frozen or contains ice shall be placed in the mixer. The temperature of the concrete shall be not less than 60 degrees F and not more than 80 degrees F at the time of placement in the forms. Under no circumstances shall concreting operations continue when the air temperature is less than 20 degrees F. No concrete shall be placed on frozen subgrade. Sudden cooling of concrete shall not be permitted.

Refer to Section 2011 of this standard for minimum required Cold Weather Curing and Protection measures.

Concrete injured by frost action or freezing weather shall be removed and replaced at the Contractor's expense.

2010 HOT WEATHER CONCRETING.
The provisions of this section shall apply to all concrete work that is done when the air temperature is above 80 degrees F at the time of placement.

The temperature of the concrete, when placed, shall not be high enough to cause excessive loss of slump, flash set or cold joints. In no case shall the temperature of the concrete, when placed, exceed 90 degrees F. Forms, reinforcing and subgrade surfaces against which the concrete is to be placed shall be wetted down immediately before placement.

When the air temperature exceeds 90 degrees F and as soon as practicable without causing damage to the surface finish, all exposed concrete shall be kept continuously moist by means of fog sprays, wet burlap, cotton mats, or other means acceptable to the Engineer. This cooling with water shall be in addition to the initial sealing by membrane curing compound.

2011 CURING AND PROTECTION.
Concrete shall be cured by protecting it against loss of moisture, rapid temperature changes and mechanical injury for at least 4 days after placement. Acceptable methods shall be moist curing, waterproof paper, white polyethylene sheeting, liquid membrane-forming compounds, or a combination thereof. After concrete finishing operations have been completed, the entire surface of the newly placed concrete shall be covered by the curing medium applicable to local conditions and acceptable to the Engineer. The Contractor shall have the necessary equipment for adequate curing on hand and be ready to install prior to concrete placement.

Moist curing shall be accomplished by a covering of burlap or other approved fabric mat used singly or in combination. Curing mats shall be thoroughly wet when applied and kept continuously wet and in intimate contact with the surface for the duration of the moist-curing period. Burlap or fabric mats shall be long enough to cover the entire surface of the work and lapped at joints to prevent drying between adjacent sheets.

Waterproof paper or white polyethylene sheets shall be large enough to cover the entire surface of the work and shall be lapped not less than eighteen (18) inches. The sheets shall be adequately weighted to prevent displacement or billowing due to wind. Tear holes appearing in the material during the curing period shall be immediately repaired or replaced with material in acceptable condition.

Clear or white membrane curing compound shall be applied after finishing operations have been completed and immediately after the free water has left the surface. The surface of the work shall be completely coated and sealed with a uniform layer of the curing compound at a rate of not less than one gallon per 150 square feet. The compound shall not be thinned and shall be kept agitated to prevent settlement of pigment. On surfaces where forms are removed prior to the end of the specified curing period, the entire exposed surface shall be coated at the specified rate of coverage. If rain falls on the newly coated surface before the film dries sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply a new coat of compound to the affected area.

During cold weather concreting when the ambient air temperature is expected to drop below 40 degrees F, sufficient supply of burlap, straw, hay, or other blanketing material shall be provided along the work to protect the concrete and maintain a minimum temperature of 40 degrees F in the concrete as measured on the surface. An approved moisture barrier such as wet burlap or plastic sheeting shall be placed on the concrete prior to placement of the blanketing material. This type of curing shall be maintained for a period of six (6) days as the initial cure.

Sidewalks, curb and gutter, and miscellaneous concrete shall be protected and cured for a period of not less than seventy-two (72) hours after the placing of the concrete by covering with wet burlap or by the application of a membrane curing compound as specified above.

2012 FORMS.
Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions

shown on the drawings. They shall be sufficiently tight to prevent leakage of mortar and shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement.

Forms may be of wood or metal and shall be designed to permit easy removal without injury to the concrete. Forms for all exterior exposed surfaces which will be visible after backfilling shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard. Forms shall be coated with an approved light oil to prevent concrete from adhering and shall be thoroughly cleaned and re-oiled before re-use.

Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete. The following table gives the approximate minimum time that forms shall be left in place.

Average Air Temperature Greater Than		**70 Deg**	**60 Deg**	**50 Deg**	**40 Deg**
Structural Member		**Time in Place (24 Hour Days)**			
Slab Shoring		10	12	14	21
Slab Forms		7	7	7	7
Beams Soffits and Shoring		10	12	14	21
Beam Side Forms		1	1	2	3
Wall Side Forms		2	2	3	4

2013 FINISHING FORMED SURFACES.
Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with backfill. A power grinder shall be used, if necessary, to remove projections and provide a flush surface. Surfaces to be damp-proofed shall have fins removed and tie holes filled, but no additional finishing will be required.

Tie holes in all formed surfaces shall be cleaned, wetted, and filled with patching mortar. Tie hole patches shall be finished flush and shall match the texture of the adjacent concrete.

The surface of all exposed formed exterior surfaces not in contact with backfill shall be finished by rubbing or by other means as directed by the City Engineer.

Sidewalks shall be “picture framed” as depicted in City of Liberty Standard details D22-1 thru D22-5.

2014 REPAIRING DEFECTIVE AND DAMAGED CONCRETE.
Any concrete found not to be formed as indicated on the plans, or out of alignment or level, or having a defective surface, or damaged prior to acceptance of the project by the City, shall be considered as not conforming to the intent of these specifications and may be ordered removed and replaced by the contractor at his expense unless the Engineer authorizes patching of the defective or damaged area. Surface defects such as ridges and bulges shall be removed by grinding. Honeycombed and other defective concrete that does not affect the structural integrity of the structure shall be chipped out and the vacated area shall be filled. The Engineer shall approve the methods used in this type of repair. Material used for patching shall be a non-shrink,

non-metallic grout with a minimum 28-day compressive strength of 5000 psi or a similar material approved by the Engineer. Prior to placement of the repair filling, the contact surface of the affected area shall be thoroughly cleaned of all loose and foreign material and shall be coated with an epoxy-bonding agent.

Concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing or surrounding concrete. Repair work shall be adequately cured and protected from further damage.

2015 REINFORCEMENTS.
The metal reinforcement shall be protected by the thickness of concrete indicated on the construction drawings. Where not otherwise shown, the thickness of concrete over the reinforcement shall be as follows:

Location of Reinforcement	**Cover in Inches**
Surfaces where concrete is deposited directly against the ground.	3
Formed surfaces exposed to the ground, to water, or to weathering.	2
Beams, girder, and columns not exposed to ground, water or weathering.	1 ½
All surfaces other than those above.	1

Reinforcing steel shall be accurately placed and positioned on supports, spacers, hangers, or other reinforcing steel as approved by the Engineer and shall be secured in place with wire ties or suitable clips. The minimum clear distance between parallel bars shall not be less than 1-2 times the diameter of round bars, except that in no case shall clear spacing between parallel bars be less than 2 inches or less than 1-2 times the nominal size of the coarse aggregate.

Splices in reinforcing steel will not be permitted at points of maximum stress. When it becomes necessary to splice reinforcing steel at points other than those shown on the contract drawings, the Engineer shall approve the character and location of the splice. Welding or tack welding of reinforcement will not be permitted. Reinforcements upon which unauthorized welding has been done shall be removed and replaced as directed by the Engineer. Spliced bars shall be placed in contact and securely tied together.

Metal reinforcement at the time concrete is placed shall be free from rust, scale, or other contaminants that will destroy or reduce the bond.

2016 CONSTRUCTION JOINTS. Construction joints shall be made at locations indicated on the drawings or specified, and shall conform to the requirements of ACI 318. When the Contractor desires to make construction joints at other locations, he shall anticipate such changes far enough in advance of the construction operations to allow the Engineer to investigate such changes and approve additional construction joints.

Sidewalk joints shall be "picture framed" in accordance with City of Liberty Standard details D22-1 thru D22-5.

2017 EXPANSION AND CONTRACTION JOINTS.
Expansion and contraction joints shall be at locations and depths indicated on the drawings (details).

Contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the concrete. Formed grooves shall be made by depressing an approved tool or devise into the plastic concrete. Sawed joints shall be constructed by sawing through the surface of the concrete with an approved concrete saw. Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to prevent excessive raveling.

Expansion joints shall be formed with pre-formed expansion joint filler of the non-extruding and resilient types which shall include the following; Cork, self-expanding cork, sponge rubber, cork rubber, and bituminous fiber. These materials shall meet the requirements of ASTM D994, D1751 and D1752.

Sidewalk joints shall be "picture framed" in accordance with City of Liberty Standard details D22-1 thru D22-5.

2018 REINFORCED CONCRETE BOX FORMING SEQUENCE.

Wall forms may be placed the day following the placement of the bottom slab, as long as care is taken to protect the slab against rough or abusive handling of forms and or placing equipment. The actual placement of concrete shall not occur prior to the fifth day after placing the bottom slab. Top forms may be placed with wall forms if the walls and top are to be of monolithic construction, otherwise top forms are not to be placed until the third day after placing the walls. The actual placement of concrete for the top shall not occur prior to the fifth day after placing the walls (for base to top shoring) or until the walls have reached their design minimum of two days after the walls are poured. Wall forms shall remain in place a minimum of two days after the walls are poured. Supports for the top slab shall be left in place according to the schedule shown ~~on page 20-5,~~ in Section 2012, Forms.

The above guidelines for placing forms for reinforced concrete boxes are based on the use of standard forming procedures and with the use of concrete containing no admixtures to achieve high early strength. Variations in forming techniques and/or the use of high early strength concrete shall only be allowed after the contractor obtains the written approval of the City Engineer.

2019 EXCAVATABLE FLOWABLE FILL.

A. Flowable Fill

Flowable Fill is a Controlled Low Strength Material (CLSM) which is often referred to as controlled density fill, flowcrete, liquid dirt or by other various trademark names. For the sake of this specification the terms Flowable Fill and CLSM shall be used interchangeably. Flowable Fill is a self-compacting and self-leveling backfill material that is used in lieu of compacted fill.

B. Sources and proportions of CLSM ingredients

Prior to the start of CLSM placement, the CONTRACTOR shall submit a description of the proposed CLSM mixture design. Based on the application, the ENGINEER may require the CONTRACTOR to submit appropriate laboratory or field test data documenting compliance to specified material and or performance properties.

C. Materials

CLSM shall be manufactured with materials conforming to the standards listed below. The ENGINEER shall approve the use of all non-conforming materials. Approval shall

be based on documentation that controlled low strength material mixtures manufactured with the non-conforming materials meet the specified plastic and hardened properties and are suited for the intended application.

- Hydraulic Cement - AASHTO M 85 or M 240
- Fly Ash - AASHTO M 295
- Granulated Blast Furnace Slag - AASHTO M 302
- Fine Aggregate - AASHTO M 6
- Coarse Aggregate - AASHTO M 80
- Lightweight Aggregate - AASHTO M 195
- Water - AASHTO M 157
- Chemical Admixtures - AASHTO M 194
- Air Entrainment Admixtures - Approved by the ENGINEER.
- Foaming Admixture - ASTM C 869

D. Flowability

Normal flowable material shall have a flow of 6 to 8 inches tested in accordance with ASTM D6103. Low flowable material shall have a maximum flow of 6 inches. High flowable material shall have a minimum flow of 8 inches. Testing shall be provided as requested by the ENGINEER at no cost to the City, testing shall be in accordance with ASTM D6103.

E. Unconfined Compressive Strength for Excavatable CLSM

Excavatability shall be evaluated on the basis of past performance and experience. When past performance records are not available, excavatability shall be evaluated on the basis of unconfined compressive strength tested in accordance with ASTM D4832. Excavatable CLSM shall have a minimum strength of 30 psi. The one-year strength shall not exceed 150 psi. In place of one year test data, the ENGINEER, may approve the CLSM mixture based on sufficient documentation, provided by the ready mix producer, that indicates the strength gain has ceased. Testing shall be provided as requested by the ENGINEER at no cost to the City, testing shall be in accordance with ASTM D4832.

F. Permeability

When required, the coefficient of permeability of CLSM shall be specified by the ENGINEER. Testing shall be provided as requested by the ENGINEER at no cost to the City, testing shall be in accordance with ASTM D5084.

G. California Bearing Ratio

When required, the CBR value shall be specified by the ENGINEER. The ENGINEER may elect to specify a minimum 28-day compressive strength in place of specifying a CBR test. Testing shall be provided as requested by the ENGINEER at no cost to the City, testing shall be in accordance with ASTM D1883.

H. Penetration Resistance

The ENGINEER may elect to specify a minimum penetration resistance (ASTM C403), hardening time, proof rolling, drop ball test (ASTM D6024), or proof that the CLSM mixture will support an individual's weight. Testing shall be provided as requested by the ENGINEER at no cost to the City, testing shall be in accordance with

ASTM C403.

I. Unit Weight
When required, the unit weight shall be specified by the ENGINEER. The manufacturer shall be permitted to select and proportion the ingredients of the CLSM mixture to meet specified requirements. Testing shall be provided as requested by the ENGINEER at no cost to the City, testing shall be in accordance with ASTM D6023.

J. Proportioning
CLSM shall be proportioned by the ready mixed concrete supplier on the basis of field experience and/or laboratory trial mixtures to produce a cohesive and non-segregating mixture meeting the specified properties.

K. Pumpable CLSM
Shall be proportioned to allow transport by pumping methods without segregating or excessive bleeding.

L. Sampling
Sampling shall be provided as requested by the ENGINEER at no cost to the City, sampling shall be done in accordance with ASTM D5971.

M. Air Content
When required the Air Content shall be specified by the Engineer. Testing shall be provided as requested by the Engineer at no cost to the City, testing shall be done in accordance with ASTM D6023.

N. Batch Records
Batch plant recordation or certified batch report should be used when a ready mixed truck is used and when it is not (ie., a volumetric mixer) then such other verification method as the supplier and customer can agree to. Acceptance shall be based on verification that the constituent materials were batched in accordance with the design. Verification shall be by inspection, automated batch plant recordation, or certified batch report. The method of verification shall be approved by the ENGINEER.

O. CLSM Properties
As required by the application, the ENGINEER shall specify acceptance tests for appropriate material properties. The testing frequency shall be specified by the ENGINEER.

P. Batching And Delivery
Material shall be batched and delivered in accordance with AASHTO M 157-86 (1996), Sections 8, 9, 10 and 11 except the temperature requirements of 11.8 and 11.9 which shall be waived.

Q. Water and Admixture Addition
The addition of water and admixtures on the jobsite is permitted. The amount of water and admixture added shall be recorded. The CLSM mixture shall be mixed for a minimum of 30 revolutions after the addition of the water or admixture.

R. Temperature
Material shall not be placed on frozen ground. The ambient temperature shall be 35 deg F and rising at the time of placement.

S. Standing Water
CLSM may be placed in confined spaces containing standing water.