SECTION 11

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CONCRETE

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1. DESCRIPTION: This work includes the furnishing of all materials, labor, equipment and services of every kind required to construct all of the concrete required as shown on the Plans and specified in these Specifications.

2. MATERIALS: Materials shall conform to the requirements of the respective Specifications described herein.

2.1 Cement: Cement used in concrete shall be Type I Standard Portland Cement conforming to the requirements of the "Standard Specifications for Portland Cement", Type I, ASTM Designation: C 150.

2.2 Fine Aggregate: This type of aggregate shall consist of natural sand resulting form the disintegration of siliceous and/or calcareous rocks or manufactured sand, produced by crushing predominantly siliceous materials. When combined with Type III cement, the resulting mortar shall develop a minimum compressive strength of 100% of the strengths obtained from specimens of the same proportions and consisting of the same cement and Standard Ottawa Sand after 24 hours and 72 hours. This aggregate shall be free from injurious amounts of organic impurities and from injurious amounts of alkali. Other deleterious substances shall not exceed the following percentages by weight:

Material passing No. 200 Sieve	2.0
Shale, lignite, coal, soft or flaky fragments	0.25
Sticks and other substances (wet)	0.25
Clay lumps (wet on No. 4 sieve)	0.25

A mixture composed of three (3) parts of this aggregate, one (1) part of portland cement and sufficient water for proper molding shall, when molded into specimens, harden completely in twenty-four (24) hours.

2.3 The fine aggregate shall be well-graded from coarse to fine and shall comply with the following size requirements:

Sieve Designations (Square Openings)	Percentage Passing (By Weight)
1/2 Inch Sieve	100
3/8 Inch Sieve	99-100
No. 4 Sieve	95-100
No. 8 Sieve	85-95
No. 16 Sieve	60-85
No. 30 Sieve	60-60
No. 50 Sieve	10-30
No. 100 Sieve	0-5

The fine aggregate shall have not more than 35 percent retained between any two consecutive sieves and the fineness modulus shall be between 2.50 and 3.10. Aggregate which shows a variation in fineness modulus greater than

0.20 more or less than that of the representative sample submitted will be rejected.

2.4 Coarse Aggregate shall conform to ASTM Designation: C 33, except as modified herein. The soundness loss ratio of the stone shall be not less than ninety hundredths (0.90) when subjected to twenty-five (25) cycles of freezing and thawing. The abrasion loss shall be not more than forty percent (40%), when the aggregate is tested in accordance with ASTM Designation: C 131. In addition to the other requirements of this Specification, acceptability of the aggregate shall be based upon satisfactory evidence furnished by the Contractor that concrete of comparable properties made from similar aggregate form the same source has not produced operationally objectionable pop-outs, and has proven satisfactory in concrete of comparable properties which has been subjected for a period of five (5) years to essentially the same conditions of exposure as those in which the aggregate to be used and in which the cement was similar to that to be used. Grading and size of coarse aggregate within the separated size groups shall conform to the following:

Sieve Designations (Square Openings)	Percentage Passing (By Weight)
1 1/2 Inch	100
1 Inch	95-100
1/2 Inch	25-60
No. 4	0-10
No. 8	0-5

2.4.1 Deleterious Substances: In lieu of Table III as given in the ASTM Designation: C 33, the deleterious substances in coarse aggregate shall not exceed the following percentages by weight when tested in accordance with the tests designated in ASTM Designation: C 33.

	Maximum Percent by Weight of Total Samples
Shale	0.5
Clay Lumps	0.25
Soft Particles	1.0
Lightweight Pieces	1.0
Material Finer than No. 200 Sieve	0.5*
Flat and Elongated Pieces	3.0
Total Amount of Deleterious Substances (Not including flat and elongated pieces)	3.0

* 1.0 percent permitted for aggregate if the fine material consists of crusher dust that is essentially free from clay or shale.

A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.5 Chemical Admixtures, when required by the project specification, shall conform to ASTM Designation: C 1017 M-98. They shall be of the type specified in the project specification. The use of calcium chloride, or other

approved accelerating admixtures, will not be permitted, except in concrete used for pavement repair.

2.5.1 The manufacturer shall furnish a certification which shall state that the materials meet the applicable specifications.

2.6 Water: Water shall be free from injurious quantities of oil, alkali, vegetable matter and salt. The water shall be reasonable clear and shall contain not more than 0.25 solids by weight. Water from city water supplies that are approved by the State for domestic use may be accepted and used without test for all concrete.

2.7 Reinforcement Steel for Concrete: Reinforcement bars shall be deformed steel bars conforming to the requirements of the "Specification for Deformed Billet-Steel Bars for Concrete Reinforcement", ASTM Designation: A 615, Grade 60. Welded-steel-wire fabric shall conform to the requirements of "Specification for Welded Steel Wire Fabric for Concrete Reinforcing", ASTM Designation: A 185, Grade 40.

2.8 Air-Entraining Admixtures shall conform to ASTM Designation: C 260. Testing in accordance with ASTM Designation: C 233 will be waived provided the admixture has been tested and accepted by the Federal Highway Administration, U.S. Dept. of Transportation, or provided a statement is submitted by the manufacturer that the admixture to be furnished for the project has been tested and conforms to ASTM Designation: C 260.

2.9 Reinforcements: Bar mats shall conform to ASTM Designation: A 184. The bar members shall be new billet steel or intermediate grade. Bars shall be deformed, and shall be clipped, wired, or fastened together by other approved means. The size and spacing of bars shall be as indicated. Welded-steel-wire fabric shall conform to ASTM Designation: A 185.

3. PRELIMINARY APPROVAL REQUIREMENTS: It is essential that the source and quality of all concrete materials offered, and the tentative concrete six proportions proposed for use on the work, be submitted by the Contractor and approved by the City before any concrete work is started. It shall be understood that the approval thus given in each case shall be a general approval only, and that continued compliance will be required regardless of any preliminary approval given.

3.2 Tentative Concrete Proportions: The Contractor shall submit to the City for approval, a tentative concrete mix for each size and gradation of aggregates and for each consistency which he intends to use on the work. If approved, each such mix shall be subject to field adjustment by the City whenever necessary to produce concrete of proper workability, uniform consistency and acceptable density and strength.

3.2.1 Each tentative concrete design or mix submitted by the Contractor for approval shall be based on the following:

a. Consistency on which mix design is based.
b. Total water per cubic yard of freshly mixed concrete required to provide the design consistency with the aggregates used.
c. Cement factor.
d. Specific gravity and gradation of each aggregate used.
e. Ratio of fine to total aggregate.

f. Weight (surface dry) of each aggregate (1) per cubic yard of freshly mixed concrete and two (2) per sack of cement in the mix.
g. Batch proportions, expressed in sacks of cement (pound if bulk cement is to be used), gallons of total water, and pounds of each aggregate. Only batches on the use of full bags of cement will be acceptable; and use of fractional bags in concrete batches will not be permitted.
h. Slump produced by the proposed concrete proportions.

3.2.2 In addition to the required design data and batch proportions, each concrete mix design submitted for approval shall be accompanied by laboratory test reports of compression tests of test specimens made from such mix as hereinafter specified.

4. STORAGE OF MATERIALS: Reinforcement steel shall be (a) carefully handled in such a manner that it will not become bent or otherwise damaged, (b) stored on racks, skids or other supports which will keep the steel from contact with the ground or surface water.

5. MEASUREMENT OF MATERIALS:

5.1 Cement: The unit of measure for portland cement shall be the sack or bag containing 94 pounds of cement. Bulk cement shall not be used except in a batching plant equipped with suitable automatic weighting and control equipment which will guarantee accurate and uniform cement batching.

5.2 Concrete Admixtures: Any concrete admixture shall be batched by means of a mechanical dispenser or other device of a design, construction and operation which will insure accurate and automatic measurement and batching of the admixture at all times. The use of calcium chloride or other accelerating admixtures in concrete mixtures shall not be authorized except in concrete used for pavement repair.

5.3 Aggregates: The measurement of all concrete aggregates shall be made by weight. The weight of each type of aggregate batched shall be that of dry aggregate corrected approximately for water or moisture content of the aggregate used.

5.3.1 Off-site batching shall be in conformity with requirements therefore hereinafter specified under "Off-Site Batching and Mixing".

5.4 Water: The regulation of water fed into the mixer shall be under the control of the mixer operator at all times. Automatic measurement of water shall be based on the minimum amount required to produce the desired slump with the aggregates used, and any additional water required to produce and maintain a uniform slump shall be admitted manually by the mixer operator through a valved bypass around the automatic measuring device.

6. LIMITING REQUIREMENTS FOR CONCRETE: The proportions of the ingredients of each concrete mix shall comply with the following limiting requirements.

Class of Concrete	Sacks of Cement Per C.Y. of Concrete (Minimum)	Gallons of Water Per Sack of Cement (Maximum)

Class B-1 Concrete	6.80	5.00
Class B Concrete	6.00	5.50

6.1 The total water-content specified in the above paragraph shall include all water added thereto at the mixer or otherwise and including all surface moisture and entrained water in the aggregates used, but shall not include any water which may be absorbed by the aggregates in the concrete during the time of mixing, conveying, placing and compacting the concrete.

6.2 The quantities of portland cement in the above paragraph are expressed a 94 pound sacks per cubic yard of freshly mixed concrete.

6.3 Ratio of Fine to Total Aggregates: The relative proportions of fine and coarse aggregates in each concrete mix shall be such that concrete of maximum density, proper workability and desired consistency is produced. In all cases, the concrete shall contain the minimum ratio of fine to total aggregates consistent with good workability. The percentage of solid volumes (not weights) of fine to total aggregates used in the mix, for a properly graded coarse aggregate, shall not exceed that shown in the following table:

Size of Course Aggregates	Percentage of Fine to Total Aggregates
1 inch	46

6.4 Slump: Permissible limits of slump for concrete will depend on the character of the aggregates, the method of compaction used, and the type and character of the construction involved. Concrete slumps shall be maintained at 2 inches and shall not exceed 3 inches.

6.4.1 In all cases, concrete slump shall be as low as possible, consistent with proper handling and thorough compaction, in order that shrinkage of the concrete be kept as low as possible.

6.5 Minimum Strength: Laboratory tests of concrete cylinder test specimens shall show minimum compressive strengths at an age of 28 days as follows:

Minimum Compressive Strength	(28 days)
Class B-1 Concrete	4000 psi
Class B. Concrete	3000 psi

6.6 Entrained-Air Content: The total calculated air content shall be 6 percent, plus or minus 1 percent, of the volume of the concrete based on measurements made on concrete immediately after discharge from the mixer.

6.7 In lieu of the Contractor having the above reference concrete material source design tests performed for the various course and fine aggregates and concrete compressive cylinder test performed for the various class of concrete used in the project, the Contractor may submit current test results for Class B concrete and Class B-1 concrete from the Missouri Highway and Transportation Commission, Standard Specification for Highway Construction, the applicable articles of SECTION 501: CONCRETE and

the submittal shall reflect aggregate gradations, aggregate quality, proportions of ingredients for each class of concrete design and concrete compressive cylinder test for each class of concrete for review and consideration by the City.

6.8 The test results shall be from a project as performed within the past nine months and must be accompanied with a certification from both the Contractor and supplier that the data is current and accurate.

7. CONSISTENCY: Concrete slump for any one concrete mix shall be kept uniform regardless of variations in moisture content of the aggregates used and in no case shall the slump of any batch exceed that authorized for the concrete being mixed by more than 20 percent. The slump of any batch of concrete which exceeds this limit may be reduced by the addition of either or both cement or aggregates, within authorized batch proportions, and the remixing of the batch. Otherwise, the batch shall be rejected and wasted as directed by the City.

7.1 Transit-mixed concrete which contains excess water when delivered to the job site, and which has a slump more than 20 percent in excess of that of the approved mix, shall be rejected by the City unless the water-cement ratio is corrected by the addition of cement at the rate of 5 percent of the authorized batch cement content per inch of excess slump, plus aggregates in regular batch proportions, and the entire batch remixed before the mixer is unloaded.

7.2 All concrete shall be of such consistency that (1) all aggregates will float uniformly throughout the mass without settling or segregation, (2) it will flow sluggishly, but not freely, when vibrated or spaded, and (3) it can be readily puddled into corners and angles of forms and around reinforcement steel.

8. TESTS OF CONCRETE AND CONCRETE AGGREGATES: With the exception of slump tests for field control of concrete consistency and gradation tests of job-batched aggregates made by or under the supervision of the City, all specified testing of concrete and concrete aggregates shall be done by an independent testing laboratory approved by the City. All costs for and in connection with such laboratory tests, including sample procurement, curing, storage, protection and transportation of concrete test specimens, and all laboratory fees, shall be assumed and paid by the Contractor.

8.1 All specified slump tests, concrete control tests and aggregates batched on the job, and the preparation of concrete test specimens shall be done by, or under the direct supervision of, the City. The Contractor shall provide, at his own expense, the services for whatever periods of time such assistance is required in the field testing of aggregates, making slump tests, and in the preparation of concrete test specimens. All subsequent handling of test specimens, including storage, curing, and delivery to the testing laboratory, shall be done by and at the expense of the Contractor.

8.2 Concrete Compression Tests: Each concrete mix submitted to the City for approval, as required by paragraph 6 hereof, shall be tested as follows: Two sets of compression test cylinders (3 cylinders per set) shall be made from concrete mixed in the proposed proportions for each coarse aggregate

gradation; one set of 3 cylinders shall be tested at an age of 7 days and the other at an age of 28 days.

8.3 All concrete test specimens shall be made in conformity with ASTM Designation: C 31, from concrete sampled as specified in the ASTM Designation: C 172, cured and stored as stipulated in subparagraphs (a) and (b) of Section 7 of ASTM Designation: C 31, and tested in conformity with ASTM Designation: C 39 Method.

8.4 Test Reports: The Contractor shall furnish the City, certified reports of all tests made by the authorized testing laboratory.

8.5 Slump Tests: For control of concrete consistency, the slump of the first pour each day and of each 50 cubic yards (or fraction thereof) of the concrete mixed for the work, and sampled as specified in ASTM Designation: C 712, shall be determined in conformity with ASTM Designation: C 143. Slump tests of transit mixed or other concrete mixed off the site of the work shall be made after its delivery to, and at the time of its unloading at, the site of the work.

9. FORMS: Forms shall conform to the shape, lines, and dimensions of the concrete as shown by the Plans and shall be constructed and maintained in accurate alignment. Lumber used in forms for exposed surfaces shall be straight, dressed to uniform width and thickness, and free from loose knots, offsets, warping, buckling, dents, holes, sags and other surface irregularities and defects which would impair the concrete surface. Joints in forms for exposed surfaces shall be either horizontal or vertical.

9.1 Concrete shall be poured against either (1) forms lined with waterproofed (exterior type) Douglas Fir plywood or tempered hard-pressed fiberboard not less than 1/4 inch thick, or (2) waterproofed Douglas Fir plywood forms, of a quality approved by the City, in all cases where the concrete will be permanently and normally exposed to view after the work has been completed.

9.1.1 Such plywood or fiberboard forms or form linings shall be installed in conformity with the manufacturer's recommendations; care shall be taken to prevent warping or buckling of the forms. Plywood or fiberboard which has become warped, cracked, split, checkered or otherwise damaged may be used only for unexposed surfaces. Forms used for backing and supporting form linings shall have flat surfaces but need not be tight. It is recommended that fiberboard linings, if used, be installed with the rough side adjacent to the concrete. Form lining shall be used in the largest practicable panels to minimize joints.

9.1.2 Metal forms may be used for unexposed surfaces regardless of location. Metal form lining will not be permitted.

9.1.3 Where walls (above footings) are required by the Plans to be poured against excavation faces, and where such excavation faces are dry or porous to the extent that loss of water from the concrete would occur, or where footings are placed on dry or porous (such as sand or

gravel) fills, the concrete shall be protected from loss of water by means of polyethylene film having a minimum thickness of .006 inch (6 mils), with all joints sealed with suitable waterproof sealing tape.

9.2 Design: Forms shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied in such a manner that they will maintain the desired position, shape, and alignment during and after placing concrete therein. Walers, studs, internal ties, and other form supports shall be of sufficient size and number, and shall be so located and spaced, that proper working stresses therein are not exceeded.

9.3 Form Bolts, Rods and Ties: Form bolts, rods or ties shall be made of steel. Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength, stiffness and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Outer ends of the permanently embedded portions of form bolts, rods or ties shall be at least one (1) inch back from adjacent outer concrete faces. Permanently embedded portions of form ties which are not provided with threaded ends shall be of a design and construction such that the removable ends are broken off by twisting only, and are removed without damage to the concrete or concrete surface.

9.4 Edge and Corner Moldings: Chamfer strips shall be placed in angles of forms to bevel all exposed edges and corners.

9.5 Top Edges: The top edges of forms for walls, foundation seats or other concrete which is to be finished to a specified elevation or slope shall be brought to a true line and grade so that the top concrete surface may be finished by means of a float or template resting on the top edges of the form or a chamfer strip. Where exposed, top edges or such concrete shall be tooled except where beveled edges are required by the Plans. Forms for wall or piers shall not extend above horizontal construction joint.

9.6 Oiling: All inside surfaces of forms shall be coated with paraffin oil or other suitable nonstaining material, applied before any reinforcement steel is placed, except that the oil may be omitted from new lacquered plywood forms the first time they are used. All surplus oil shall be removed from the coated surfaces with soft absorbent cloths.

9.7 Openings for Inspection and Cleaning: Temporary openings shall be placed at the bottom of the column and wall forms, and at other points where necessary to facilitate cleaning and inspection immediately before depositing concrete.

9.8 Form Removal: Forms shall not be removed or otherwise disturbed until the concrete has attained sufficient strength to support safety all dead and live loads to be imposed thereon. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage or other damage to the concrete.

9.8.1 Forms for slabs, foundations and walls shall not be removed for 1 to 3 days following the concrete placement. Under special conditions foundations, retaining walls or special structures have been constructed, the following applies: If equipment is available for making and breaking test beams on the project, the forms be removed on the day following the day that the concrete has attained its design

strength as determined by the City. Design flexural strength shall be five hundred forty (540) pounds per square inch or 3000 psi compressive strength for Class B Concrete and seven hundred twenty (720) pounds per square inch or 4000 psi compressive strength for Class B-1 Concrete. During cold weather, the above time limits shall be increased at the discretion of the City depending upon the amount of protection and curing afforded the concrete. Special notes on the Plans relative to the removal of forms for special structures shall have precedence over the above time limits for removal of forms.

10. CONCRETE REINFORCEMENT:

10.1 Fabrication: Metal reinforcements shall be accurately formed to the dimensions shown on the Plans or according to City's Standard Details. Details of the fabrication of reinforcing steel shall, unless expressly shown on the Plans or specified herein, comply with the current standards of the American Concrete Institute. Such standards include the Manual of Standard Practice for Detailing Reinforced Concrete Structures ACI 315. All bars shall be bent cold. Bars shall not be rebent or straightened in a manner which would injure or reduce the strength of the material. Bars with kinks or bends not shown by the Plans shall not be used.

10.2 Placing Reinforcement: Metal reinforcement shall be accurately positioned, secured against displacement by using annealed iron wire ties or suitable clips at intersections, and supported by metal supports, spacers, or hangers.

10.2.1 With the exception of lapped portions of spliced bars which are wired or clamped together, the clear distance between parallel bars shall be not less than 1.5 times the maximum size of coarse aggregate in the concrete, or less than 1 inch in beams, or 2 inches in other locations. Where reinforcement is placed in two or more layers, the bars in the upper layers shall be placed directly above those in the bottom layer.

10.3 Protective Embedment: Where not otherwise shown, steel reinforcements shall be protected by the thickness of concrete given in this article for the applicable designated location in each case, each such thickness being the shortest distance between the concrete surface or form and the nearest surface (not center) of the adjacent primary reinforcement, with a tolerance or variation which will not exceed 1 percent of the depth of thickness of the concrete section involved:

The minimum covering shall be not less than two (2) inches except as follows:

Location of Reinforcement	Minimum Cover
Top of Slab	2 Inches
Bottom of Slab	1 Inch
Walls	1 1/2 Inches

10.3.1 In the footings of foundations and retaining walls, the minimum covering shall be 3 inches.

10.3.2 All main load carrying bars shall be adjacent to exposes or form contact surfaces, the secondary reinforcements being installed inside the main load carrying bars.

10.4 Splices: The full strength of each spliced bar shall be in accordance with the most current version of ACI 318 or as shown on the plan; however in no case shall the splice length be less than 30 bar diameters.

11. MIXING CONCRETE AT SITE OF WORK: The mixing of concrete at the site of the work shall be done in a batch mixer of a type and construction which will insure uniform distribution of all batch ingredients throughout the entire mass of the batch. Each mixer shall be equipped with a mechanically operated timing and signaling device which will indicate and assure the completion of the required mixing period and which will count the batches. Mixers shall not be loaded in excess of their rated capacity.

11.1 The ingredients of each batch of concrete shall be mixed for a period of1 1/2 minutes after all ingredients are in the mixer, during which period the mixer shall rotate at a peripheral speed of approximately 200 feet per minute. Water shall be added prior to, during and following the mixer changing operations as necessary to produce concrete of uniform consistency and slump regardless of fluctuations in moisture content of the aggregates used. Each batch shall be completely discharged before recharging the mixer.

11.2 Retempering: Any and all concrete or mortar that has stiffened or hardened to the extent that it is no longer plastic and workable shall be wasted as directed by the City. In no case shall such material be retempered or otherwise reconditioned and used in permanent construction of any kind.

11.3 Condition of Equipment: All concrete equipment and tools shall be clean and free from any accumulation of hardened concrete or mortar at the time concrete work is started and shall be maintained in such condition throughout the entire period of its use on the work. Any mixer that at any time produces unsatisfactory results because of its mechanical condition shall be repaired promptly or it shall be replaced.

12. OFF-SITE BATCHING AND MIXING: All requirements heretofore stipulated relative to concrete materials, mix design, proportioning, limiting factors, total water content, workability, consistency, control and testing shall apply to concrete batched and mixed away from the site of the work, and any and all concrete so batched and mixed which does not conform to all specified requirements when delivered to the job will be rejected and shall be removed from the site of the work and disposed of in a manner acceptable to the City. Special attention shall be given to maintain uniformity of water-cement ratio and slump of the concrete when delivered. Continuous and accurate control of the total water content of the concrete, involving frequent determinations of moisture content of the aggregates used, will be expected and required.

12.1 Truck Mixing: Mixing shall be completed in a truck mixer within not less than 50 nor more than 150 revolutions of the drum or blades, at the rate or rotation designated by the mixer manufacturer as "mixing" speed. Additional mixing, if any, shall be at a speed designated by the mixer manufacturer as

"agitating" speed. Mixing shall begin within (a) 15 minutes after the addition of cement to either water or aggregates when the air temperature is 90 degrees F or above, (b) 20 minutes at an air temperature between 70 degrees F and 90 degrees F, and (c) 30 minutes at lower air temperatures.

12.2 Transporting Ready-Mixed Concrete: Ready-mixed concrete shall be transported in a truck mixer, agitator, or other similar device and shall be discharged at the job within one and one half (1 ½) hour after the cement has been added to the water or aggregates. A truck mixer or agitator used for transporting ready-mixed concrete shall not be loaded, or rated, in excess of 80 percent of the gross volume of the drum.

13. HANDLING AND PLACING CONCRETE: Before starting mixing and placing operations, the forms and all steel reinforcements, key forms and metal sealing strips for construction joints, bulkheads, anchor bolts, wall castings and other embedded fixtures and appurtenances shall be rigidly secured in proper position and the entire installation thereof shall be inspected and approved by the City; all dirt, mud and debris shall be removed from the space to be occupied by the concrete; and all surfaces which may have become encrusted with dried mortar or grout from previous concreting operations shall be cleaned before any new concrete is placed in contact therewith. On projects where ready-mixed concrete is used, the Contractor shall not place an order for the delivery of concrete unit all of the above items are in compliance and the City approves the ordering of concrete.

13.1 Removal of Water: Water shall be removed from the space to be occupied by the concrete before concrete is deposited. Any flow of water into an excavation shall be diverted, or removed by approved methods which will avoid washing the freshly deposited concrete.

13.2 Bonding to Harden Concrete: Adequate provisions shall be made for properly bonding new to hardened concrete. Surfaces of unformed construction joints shall be screeded, floated, brushed or otherwise cleaned and roughened after initial and prior to final set wherever possible. Hardened unformed concrete surfaces which were not so prepared shall be cleaned of all laitance and surface film and roughened to the extent necessary to provide aggregate exposure over the entire areas in each case. All hardened concrete shall be washed clean and free of surface coating and loose material by means of high pressure water jets or by brooming and flushing, and shall be damp when the new concrete is placed thereon. Concrete which has dried out shall be saturated with water for at least 24 hours prior to being covered with new concrete.

13.3 Conveyance and Distribution of Concrete: Concrete shall be conveyed from the mixer, truck, or receiving hopper to the point of final deposit as rapidly as practicable and by methods which will prevent the separation or loss of the ingredients. Under no circumstances shall concrete which has partially hardened be deposited in the work. Conveyance and distribution of concrete shall be such that the concrete is deposited in forms, as nearly as it practicable, at and in its final position without dropping it vertically, except in a chute or pipe, for more than 3 feet and without rehandling or moving the concrete laterally in the forms for a distance in excess of five (5) feet from the

point of application; and such that the concrete, as deposited, will maintain a plastic surface approximately level until the completion of the unit.

13.4 Depositing Concrete: The extent and limits of each concrete pour shall be predetermined by the Contractor and all concrete to and within such limits shall be deposited in one continuous and uninterrupted operation.

13.4.1 Concrete shall be deposited in continuous and approximately horizontal layers of suitable and proper depth for effective compaction by the method used; in no case, however, shall such depth exceed 20 inches. The concreting methods and procedure used shall be such (1) that each layer of concrete shall be plastic and workable when covered with the following layer and (2) that the forms shall be filled at a rate of vertical rise of the concrete surface of not less than 2 feet per hour.

13.5 Compacting Concrete: During and immediately after depositing, all concrete shall be thoroughly compacted, and worked around all metal reinforcements and into corners of forms, by means of suitable tools.

13.5.1 Unless otherwise permitted by the City in each case, all concrete shall be compacted by means of mechanical vibrating equipment. Vibration equipment shall be of a type, construction and arrangement suitable for the required work and shall be acceptable to the City. Vibrating equipment used shall be high-speed, immersion-type vibrators operating at not less than 6000 RPM when immersed in the concrete.

13.5.2 In consolidating each layer of concrete, the vibrator shall be brought to a vertical position and the vibrating head shall be allowed to penetrate and re-vibrate the concrete in the upper part of the underlying layer. Vibrator insertion spacing shall be such that the vibrated areas will overlap. Care should be taken that internal vibrators do not come in contact with forms for exposed surfaces. Each layer of concrete shall be thoroughly consolidated before the next layer is placed thereon at any point.

13.5.3 Internally vibrated concrete shall be thoroughly rodded and spaded around small recesses and at other points which are inaccessible to, and are outside the effective radius of vibration of the vibrating equipment. All concrete placed against vertical or approximately vertical forms shall be spaded away from the form by means of slotted blade concrete spades or tampers in such a manner that mortar will be worked to the face of the forms without segregation or formation of sand streaks on the surface of the concrete.

13.5.4 Great care and caution shall be taken and observed on the part of each vibrator operator not to over-vibrate the concrete. Vibration shall always be stopped before any segregation or horizontal stratification of the concrete occurs.

13.5.5 Accumulations of water on the surface of the concrete due to water gain, segregation, or other causes, during placement and compacting, shall be prevented as far as possible by adjustments in the mixture,

and if caused by over-vibration of the concrete, the vibration period and methods shall be changed to eliminate such accumulations of water. Provisions shall be made for the removal of such water as may accumulate so that under no circumstances will concrete be placed therein.

13.6 Depositing Concrete Under Water: No concrete shall be deposited under water without the specific approval of and under conditions prescribed by the Design Engineer.

13.7 Cold Weather Requirements: The temperature of concrete when deposited at designated outdoor temperatures (in shade) at the time of mixing shall be not less than:

Air Temperature	Minimum Concrete Temperature
Below 30 degrees F (no concrete shall be placed)	
Between 30 degrees F and 50 degrees F	60 degrees F
Above 50 degrees F	50 degrees F

13.7.1 When deposited, the temperature of heated concrete shall be not over 80 degrees F. Within the limit of its heating capacity at a maximum allowable temperature of 165 degrees F, hot water shall be used for producing heated concrete. Where additional heat is required, the concrete aggregates may be heated by means of steam coils placed in the storage pile or bin, by means of live steam injected into the aggregate, or (where only a small amount of concrete is to be heated and where satisfactory precautions are taken to prevent damage to the aggregate by overheating) by means of fire within a large steel pipe over which the aggregates are placed.

13.7.2 During freezing weather, or when freezing temperatures may be expected during the curing period, suitable and adequate means and facilities shall be provided (a) for maintaining the concrete surfaces at temperatures not less than 50 degrees F. for five (5) days or 70 degrees F. for three (3) days after the concrete is placed and (b) for keeping concrete and adjacent form surfaces moist at all times. Sudden cooling of protected concrete shall not be permitted, and gradual cooling shall be accomplished by shutting off the heat and allowing the enclosure to cool to approximate outside temperatures; in any case, the housing, covering or other protection provided shall remain in place for not less than 24 hours after artificial heating is discontinued. Coverings or housing shall be arranged to permit free circulation of air above and around the concrete within the enclosure. All air currents from without shall be excluded except for necessary ventilation for salamanders if and where used. Special care shall be taken to exclude cold drafts from angles, corners, and projecting reinforcing steel.

13.8 Hot Weather Concreting: Concrete placing and finishing operations during hot weather shall be done as quickly as possible. Ample personnel shall be available to handle and place concrete immediately after its mixing or delivery at the site of the work. Concrete shall be placed in layers thin enough, and over areas small enough, to insure complete bond and union of adjacent and thus prevent "cold joints".

13.8.1 At air temperatures of 90 degrees F. or above, the following precautions shall be taken;

a. In no case shall the temperature of the concrete exceed 90 degrees F. when placed in the work.

b. Forms, reinforcements, and subgrade surfaces shall be wet down immediately before concrete is placed in contact therewith. Wetting down of areas around the work to cool the surrounding air and increase the humidity, is recommended.

c. Concrete shall be kept as cool as possible during the specified curing period. When ambient air temperatures exceed 90 degrees F, and as soon as practicable without damage to the surface finish, all exposed concrete shall be kept continuously moist by means of fog sprays, wet burlap or cotton mats, or other effective methods. Such water cooling to be in addition to initial surface sealing by membrane curing compound, if used.

13.8.2 The cement factor used in the approved concrete design mix shall be increased when and as necessary to maintain the specified maximum water-cement ratio in all cases where additional water is added to compensate for loss of slump during transportation, handling or placing.

14. CONSTRUCTION JOINTS: Construction joints, both vertical and horizontal, shall be made at locations indicated on the Plans and at such other locations as designated or approved by the City, and shall be so designed and located that the strength and appearance of the structure are not impaired.

14.1 Keys shall be provided in all joints where required to provide for either shear or water tightness. Where joints occur at or near points of maximum shear, such as at the base of walls or pier shafts, the width of the keys shall be one-third the thickness of the section at that point. Depth of keys shall be approximately one-half the key width in each case.

15. REPAIRING DEFECTIVE CONCRETE: Unless otherwise approved in each case, defects in formed concrete surfaces shall be repaired within 24 hours and defective concrete shall be replaced within 48 hours after the forms adjacent thereto have been removed. Wherever possible, concrete repairs or replacements should be made before the defective concrete is 7 days old. Hardened concrete surfaces shall be thoroughly dampened and coated with thick grout immediately prior to applying repair mortar or concrete.

15.1 Surface voids in honeycombed areas where the depth of defective concrete does not exceed one (1) inch at any point thereof, rough or otherwise porous areas, and holes resulting from the removal of form ties or parts thereof, shall

be completely filled with portland cement mortar mixed in volumetric proportions of one (1) part cement to two (2) parts of clean sand which has been screened to pass a No. 8 sieve. Mortar used for filling surface voids, and recesses larger than 1/4 inch in minimum dimension resulting from the removal of form tie ends, shall be mixed with just enough water to produce mortar that will stick together when molded into a ball by slight pressure of the hands, and which will leave the hands damp without exuding water when so pressed. Mortar used for filling smaller form tie openings, and for filling bolt holes which pass entirely through concrete which is to be water tight, shall be mixed with no more water than is necessary to produce mortar of a suitable and proper consistency for complete filling and packing of the holes. Where adequate mechanical bond is not provided by re-entrant surfaces of voids in rough or honeycomb surfaces, such surfaces shall be coated with thin neat cement grout immediately prior to application of the mortar. Filling of surface voids and holes shall be done by solidly ramming and tamping mortar into isolated holes, and by rubbing, filling and compacting mortar into voids and holes of honey-combed and other porous areas by means of a small wood block or float which shall be applied to the mortar with sufficient pressure and in such a manner (using a circular rubbing or grinding motion) that all voids in the concrete are completely filled; rubbing shall be continued until the finished surface is flush with that of adjacent concrete. Final finish shall be by means of a wood or cork float; the use of a metal float or steel trowel will not be permitted.

15.2 All concrete which is porous, honeycombed, or otherwise defective to a depth in excess of one (1) inch from the concrete surface at any point shall be cut out and removed entirely, including the removal of sound concrete to the extent necessary to provide a concrete replacement depth below the normal concrete surface of not less than two (2) inches over the entire area of the repair; all cut edges shall be sharp and slightly undercut to the extent that the new concrete fill will be securely keyed in place, except that undercutting of edges will not be required where adequate anchorage is provided by exposed reinforcement bars. Replacement concrete used in repair work shall be mixed in the same proportions, and shall be made with materials from the same source in each case, as used for the original adjacent concrete except that less water and a lower water-cement ratio may be used to produce a lower slump concrete if desired.

15.3 Concrete repair work shall be performed in a manner that will not interfere with thorough curing of the surrounding concrete. All mortar and concrete used in repair work shall be thoroughly and adequately cured as hereinafter specified.

16. FINISHED FORMED SURFACES: All fins and other surface projections shall be removed from formed concrete surfaces in any location except exterior surfaces in contact with earth backfill below finished grade elevation.

16.1 Finishing methods used will depend on the age and hardness of the concrete when it is surface finished. The method used in each case shall be acceptable to and approved by the City.

16.2 The surface side of all curbs shall be given a rubbed surface finish.

16.3 The City may require the use of a dry carborundum brick for straightening mounding lines, removing fins, etc., or may require a rubbed surface finish on all surfaces which do not present an acceptable surface even when form lining is used.

17. FINISHING UNFORMED SURFACES: No screeding, floating, or other surface treatment, beyond that necessary to obtain required surface elevations or contours and (where beneath superimposed concrete) surfaces free of laitance, mud and debris will be required for concrete seals, footings, or other buried or permanently submerged concrete. The unformed surfaces of foundations, and retaining walls shall be given an initial hand-float finish; this initial float finish to be followed by additional floating and troweling where and as hereinafter specified.

17.1 Screeding: Screeding shall be done at such a time, and in such a manner, that all coarse aggregate shall be completely embedded in adjacent mortar and that the screeded surface shall conform accurately to, and will remain, at the required elevation, line, grade, slope or contour in each case. All screeded surfaces shall be "jitterbug" tamped or rolled immediately prior to final screeding, to the extent necessary to force all coarse aggregate particles below the concrete surface and to provide sufficient excess mortar for proper and satisfactory finishing by the method used in each case. All surfaces which are to be given a final finish with float, broom, or trowel shall be free of holes, pits, grooves, depressions, ridges, humps, or other surface irregularities with a vertical height or depth in excess of 1/8 inch as measured from a 10 foot straightedge.

17.2 Floating: Hand floats shall be used for all floating operations.

a. Initial Floating: All screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which may be disturbed by the float, or which causes a surface blister, water pocket or other surface defect, shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, free of screed marks, with no unnecessary working of the surface with the float.

b. Surface Reconsolidation: In no case will initial floating alone be acceptable for any exposed surface. Reconsolidation of such surfaces with a hand float at the time of initial set, for the prevention of surface checking or shrinkage cracks, is important and necessary and shall not be omitted.

Where no further surface treatment with broom or trowel is required, such surface reconsolidation shall produce a smooth, uniform and workmanlike float finish of uniform texture and color.

17.3 Troweling: Troweling shall be performed on surfaces to be occupied by the bridge shoes. Troweling shall be as follows: When the floated reconsolidated surface has hardened sufficiently to prevent an excess of cement from bring drawn to the surface, steel troweling shall be started and

performed with a firm pressure which will flatten the sandy texture of the floated surface and produce a dense and uniform surface free of blemishes and trowel marks.

17.4 Edging: All exposed edges of floated or troweled surfaces shall be edged with a tool of small corner radius. Edging shall be done in a manner that will not raise the edges or surface of the concrete, leave depressions therein or otherwise interfere with surface drainage.

18. CURING OF CONCRETE: All concrete made with standard portland cement shall be protected from loss of moisture for a period of not less than seven (7) days from and after the concrete is placed, except that when concrete is being protected from low temperatures, the time period for curing by saturation shall be one (1) day less than the duration of the low temperature protection. Concrete made with high-early-strength cement shall be cured for a period of not less than 48 hours, except where protection from low temperature is being provided. All concrete shall be protected from loss of moisture whether exposed or not and, where necessary to provide adequate protection, more than one method of curing shall be used for different parts of the same unit of concrete construction.

Curing of concrete shall be by (a) continuous surface saturation or inundation, (b) airtight coatings on unformed surfaces where specifically permitted, or (c) other method which will insure that all concrete surfaces are kept adequately and continuously wet during the specified curing period.

18.1 Water Curing: Water curing may be accomplished (a) by flooding, (b) by continuous application of water by means of porous hose, perforated pipes, sprinklers, or spray nozzles, so arranged and located that all surfaces of the concrete are kept continuously saturated, or (c) by intermittent sprinkling, in which case the entire areas shall be covered with suitable and approved absorbent material which will retain free water for the entire time between sprinklings.

18.1.1 Concrete walls and shafts should be cured, wherever possible, by means of water supplied to and on the top wall surfaces for the full length thereof by means of seepage through porous or perforated hose or other approved method, in such a manner that the entire wall surfaces (and forms thereon until removed) are kept saturated at all times. The rate of water application should be regulated to provide complete wall surface coverage with a minimum of bottom run-off. Regardless of the method of surface saturation used, the application of water to tops of walls or columns is to be interrupted for surface rubbing to repair areas only over the areas being rubbed at any one time and in no case shall the concrete surface be permitted to become dry during such interruption.

18.1.2 Concrete slabs, curbs, sidewalks and parapets shall be covered with wet burlap, moisture-proofed burlap, or other approved impermeable material immediately after the finishing operations have been completed and marring of the concrete will not occur. This type of curing shall be maintained for a period of seven (7) days. The burlap cure shall be maintained in a saturated condition for the full curing period and shall be so placed and weighted down as to cause it to

remain in intimate contact with the surface covered. If any of the curing materials become perforated or torn, it shall be immediately repaired or discarded and replaced with acceptable material.

18.1.3 Other concrete surfaces shall be kept continuously wet throughout the curing period in a manner acceptable to the City. In all cases, water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete and within 12 hours in dry weather and 24 hours in damp weather after the concrete has been deposited. Where burlap or similar absorbent material is used to aid in distribution of water over the concrete surfaces or, in the case of walls, to reduce the amount required for complete coverage or the amount of water runoff, such material shall be kept in close contact with the concrete at all points.

18.2 Membrane Curing: Membrane curing compound may be used in lieu of water curing only on top surfaces of concrete slabs, sidewalks, foundations or walls. Membrane curing compound shall be chlorinated rubber meeting the specifications AASHTO M-148.

18.2.1 Membrane curing compound shall be applied in one coat only within thirty (30) minutes after final finishing of the surface coated, and at a uniform rate of not to exceed 150 square feet of surface coated per gallon of Type I material, with full allowance being made for waste and wind losses.

18.2.2 All curing compound shall be applied by means of pressure type spray equipment, DeVilbiss NJE-620 or equal, equipped with a feed tank agitator which will provide continuous agitation of the compound during coating operations.

19. ANCHOR BOLTS: All anchor bolts which are cast in place in concrete shall be provided with sufficient threads in each case to permit a nut to be installed on the concrete side of the concrete form or supporting template. When the bolt is installed, a second nut shall be attached to the bolt on the outside of the from or supporting template, and the two nuts adjusted and tightened in such a manner that the bolt will be rigidly held in proper alignment.

19.1 When anchor bolts are set during the placing of the concrete, they shall be accurately located and held firmly in a rigid template which spans the concrete with sufficient clearance to permit proper finishing of the surface of the concrete. The template shall remain in place until the concrete has set. Where permitted or required, the anchor bolt wells may be omitted and, in lieu thereof, holes drilled into the substructure. The anchor bolt holes shall be drilled in the exact location shown, to the required depth, perpendicular to the plane of the bridge seat, and just prior to the time of setting the anchors. The drilled holes shall not be smaller than the diameter of the holes in the steel bearing plates or castings. When the anchor bolts are set in holes or wells, they shall be grouted in by using an expansive mortar meeting the requirements specified herein. Excess mortar forced out of the hole shall be

removed. The location of anchor bolts in relation to the center of slotted holes provided in movable plates and shoes shall be varied to compensate for movement of spans due to the temperature above or below 60 degrees F.

20. GROUTING: Grouting of reenforcing steel into previously poured concrete shall be at locations as shown on the Plans.

20.1 The holes shall be drilled one (1) inch larger than the diameter of the reinforcing steel to be grouted into the concrete and in such a manner that the adjacent concrete will not be injured. After the hole is drilled, it shall be thoroughly cleaned while dry and then scrubbed with a fiber brush and clear water to remove all traces of loose material.

20.2 Immediately prior to placing the reinforcing steel, the concrete shall be dried of all surface moisture.

20.3 After placing the reinforcing steel, the hole shall be completely filled with an approved epoxy grout or an approved non-shrink grout. The grout shall be mixed, applied, and cured according to the manufacturer's recommendations.

20.4 The grout shall be applied so that all the holes are completely filled and no voids exist between the reinforcing steel and the concrete.

21. OPENINGS IN CONCRETE: Openings provided in concrete walls for piping and other appurtenances which are to be installed after the walls are constructed to obtain proper position, alignment, or for any other reason, shall be of sufficient size that adequate space is available for the proper compaction of concrete placed around such embedded pipe or fixture. All sides of each opening shall be provided with continuous keyways as hereinbefore specified for construction joints. The top of each opening shall be sloped or leveled to provide adequate space for placing and compacting the pipe embedment concrete.

21.1 Where any such opening is in a wall subject to hydrostatic head or pressure at or above the elevation of the opening by reason of ground or flood water without or water stored within the structure containing the wall, all sides of each such opening shall be provided with continuous metal water stops.

22. WEEPHOLES: Weepholes of the sized specified shall be installed at the locations shown on the Plans. Material, other than plastic tubing, used for sleeves in the forms to form the weepholes shall be of a type that can be removed after the concrete forms are removed. If plastic material is used, it may remain in place.

22.1 Porous backfill shall be placed behind retaining walls at the locations and to the dimensions shown on the Plans. Material used for porous backfill shall meet the same requirements and the gradation of the coarse aggregate used in the concrete.

23. CONCRETE ENCASEMENT:

23.1 Concrete Encasement of Sanitary Sewer Pipe: Concrete encasement of sanitary sewer pipe shall be installed where and as shown by the Plans; also where, in the opinion of the City, such pipe reinforcement is necessary because of any unforeseen condition encountered in the work.

23.1.1 Concrete used in pipe encasement shall be furnished, placed and compacted in conformity with the requirements as set forth herein.

23.1.2 Concrete encasement of sanitary sewer pipe shall be preceded by the following preliminary steps:

a. Each length of pipe shall be installed on a suitable block or other support located close to the pipe bell, and the pipes brought to exact line and grade by means of wedges placed on each side of the pipe.

b. Each length of pipe shall be rigidly held in lateral alignment by means of either struts between the pipe barrel and the trench bank installed at the spring line or pipe launch, or by means of wedges placed beneath and on each side of the pipe after the top anchorage described in the following subparagraph c. is in place. Such lateral supports shall be installed immediately back of the bell of each pipe. All lateral bracing of the pipe shall be done prior to filling the pipe joints with the jointing material.

c. Each pipe shall be anchored, to prevent flotation by means of a vertical strut placed immediately back of each bell, such strut being securely attached to, or wedged beneath, a cross brace or member preferably anchored to a horizontal plank on each side of the trench, although such thrusts may be wedged between vertical bracing planks. In any case, cleats shall be nailed across the tops of the cross member and into the side planks to properly resist upward thrust. The cross brace and side planks shall be kept above the top of the concrete fill, with the bottom edges of the cross braces preferably at the top elevation of the concrete as a guide in the placement thereof to the proper thickness above the top of the pipe barrel.

d. Pipe joints shall be filled or otherwise sealed with the same materials and in the same manner as other joints in the same line of sewer.

e. All loose material shall be removed from the trench prior to placing any concrete therein. The concrete as installed shall have a continuous and uniform contact with undisturbed trench excavation material on both sides and the bottom of the trench except (1) where side forms are indicated or permitted by the Plans or (2) where sheeting is left in place in the trench, in which case the concrete is to be poured directly against the sheeting.

24. ACI REFERENCES

24.1 ACI 116R – Cement and Concrete Terminology.

24.2 ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

24.3 ACI 211.2 – Standard Practice for Selecting Proportions for Structural Lightweight Concrete.

24.4 ACI 212.3R – Chemical Admixtures for Concrete.

24.5 ACI 304R – Guide for Measuring, Mixingm Transporting, and Placing Concrete.
24.6 ACI 304.2R – Placing Concrete by Pumping Methods.
24.7 ACI 305R – Hot Weather Concreting.
24.8 ACI 306R – Cold Weather Concreting.
24.9 ACI 318 – Building Code Requirements for Structural Concrete.
24.10 ACI 347R – Recommended Practice for Concrete Formwork.

25. ASTM REFERENCES

25.1 ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
25.2 ASTM A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
25.3 ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
25.4 ASTM A775 – Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
25.5 ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
25.6 ASTM C33 – Standard Specification for Concrete Aggregates.
25.7 ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
25.8 ASTM C94 – Standard Specification for Ready-Mixed Concrete.
25.9 ASTM C138 – Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
25.10 ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete.
25.11 ASTM C150 - Standard Specification for Portland Cement.
25.12 ASTM C157 – Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
25.13 ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete.
25.14 ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
25.15 ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
25.16 ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
25.17 ASTM C289 – Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
25.18 ASTM C309 – Standard Specification for Liquid Membrane-Forming Compunds for Curing Concrete.
25.19 ASTM C330 – Standard Specification for Lightweight Aggregates for Structural Concrete.

25.20 ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.
25.21 ASTM C496 – Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
25.22 ASTM C567 – Standard Test Method for Determining Density of Structural Lightweight Concrete.
25.23 ASTM C595 – Standard Specification for Blended Hydraulic Cements.
25.24 ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural pozzolan for Use in Concrete.
25.25 ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
25.26 ASTM D882 – Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
25.27 ASTM D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
25.28 ASTM D1056 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
25.29 ASTM D1709 – Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
25.30 ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
25.31 ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
25.32 ASTM E329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
25.33 ASTM E1745 – Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

26. COE REFERENCES

26.1 CRD-C572 – Specifications for Polyvinylchloride Waterstops.
26.2 CRD-C621 – Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink).

END OF SECTION