Chapter amendments approved:	OMPC	Owensboro	Daviess Co.	Whitesville
2002 Revised Public Improvement Specifications (new chapter)	08-Aug-02	No action required by legislative bodies		

13.0 PURPOSE. The purpose of this chapter is to outline the requirements for proper concrete materials and methods in the construction of public facilities.

13.1 DESCRIPTION OF WORK. Concrete shall consist of a mixture of Portland cement, fine aggregate, coarse aggregate, and water, with air entrainment as specified, combined in the proportions and mixed to the consistency specified, and shall be formed or cast to dimensions indicated on the Plans or as directed by the Engineer. The Contractor shall provide materials, material proportions, equipment, and construction methods that will ensure that concrete produced meets the requirements of these Specifications.

13.2 MATERIAL

13.2.1 Portland Cement Concrete

a. Portland Cement. Portland cement shall meet requirements set forth in ASTM C 150, Standard Specification for Portland Cement, for Type I or Type II cement, and the requirements set forth in ASTM C 595, Standard Specification for blended hydraulic cements, for Type IP cement.

b. Water. Water used in mixing or curing Portland cement concrete shall meet the requirements set forth in the KTC Specifications.

c. Fine Aggregates. Fine aggregates shall meet the requirements set forth in the KTC Specifications.

d. Coarse Aggregates. Coarse aggregates shall meet the requirements set forth in the KTC Specifications.

e. Air-Entraining Admixtures. Air-entraining admixtures shall meet the requirements set forth in ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete, except the chloride content shall not exceed two (2) percent by weight.

f. Chemical Admixtures. Chemical admixtures shall meet the requirements set forth in ASTM C 494, Standard Specification for Chemical Admixtures for Concrete, except the chloride content shall not exceed two (2) percent by weight.

g. Fly Ash. Fly ash shall meet the requirements set forth in ASTM C 618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a mineral admixture in Portland cement concrete, for Class F Fly Ash.

13.2.2 Concrete Reinforcement

a. Steel Bars. Steel reinforcing bars shall be deformed bars meeting the requirements of ASTM A 615, Standard Specification for deformed and plain billet-steel bars for concrete reinforcement. All bar reinforcement shall be Grade 60 bars. When epoxy coated steel reinforcing bars are used, epoxy coated fie wire shall be required.

b. Welded Steel Wire Fabric. Welded steel wire fabric shall meet the requirements set forth in ASTM A 185, Standard Specification for Steel Welded Wire Fabric for Concrete Reinforcement.

c. Polypropylene Fibers. Fibers shall be 100 percent polypropylene fibers specifically designed for use as concrete reinforcement and shall contain no reprocessed olefin materials. No textile waste materials or other textile products will be allowed.

13.2.3 Curing and Finishing Materials

a. Concrete Curing Materials. Concrete curing materials shall meet the requirements set forth in the KTC Specifications, for type 1D Clear, Class B.

b. Masonry Coating Materials. Masonry coating materials shall meet the requirements set forth in the KTC Specifications current edition.

13.3 EXECUTION OF WORK

13.3.1 Care, Storage and Handling of Concrete Materials. Aggregates, cement, and fly ash shall be furnished, stocked and handled at the plant in accordance with the requirements set forth in the KTC Specifications.

13.3.2 Admixtures. Chemical admixtures to improve workability, retard and/or accelerate the time of set shall be used where specified or directed on the approved plans. When not specified or directed for use, these admixtures may be used only upon approval of the Project Engineer. Determination of quantities of water-reducing and retarding admixture required to produce the desired results shall be the responsibility of the Contractor. The Contractor shall also establish the quantity of air-entraining admixture necessary to produce a concrete mixture having a net air content, by volume, of 5.5 plus or minus 1.5 percent.

13.3.3 Proportioning. Proportioning of concrete mixtures shall be in accordance with the KTC Specifications. For concrete exposed to sewage, the mixture shall contain the necessary proportions of Type II, Type IP, or Type I cement and fly ash to ensure a maximum Tricalcium Aluminate content of eight (8) percent of the total weight of cementitious materials.

13.3.4 Class of Concrete. The following classes of concrete shall be as specified in the KTC Specifications and shall be used in the types of construction designated, unless shown otherwise on the Plans, in the Contract, or directed by the Engineer. Concrete of all classes and for all uses above grade shall be air-entrained.

a. Class AA Concrete - shall be used in structural concrete. It shall have a minimum 28-day compressive strength of 4,000 psi, a minimum slump of two (2) inches and a maximum slump of four (4) inches. For fiber reinforced concrete, a tolerance of + one (1) inch shall be allowed outside the minimum and maximum specified.

b. Class A Concrete - shall be used in cast-in-place sewers, headwalls, catch basins, manholes, small retaining walls, culverts, sidewalks, curbs, driveways, paved ditches and paved channel linings. It shall have a minimum 28-day compressive strength of 3,500 psi, a minimum slump of two (2) inches and a maximum slump of four (4) inches. For fiber reinforced concrete, a tolerance of + one (1) inch shall be allowed outside the minimum and maximum.

c. Class B Concrete - shall be used in concrete encasements, caps, cradles, stacks, gravity retaining walls and for all non-reinforced concrete deposited as fill for cavities or voids and mass footings. It shall have a minimum 28-day compressive strength of 2,500 psi, a minimum slump of three (3) inches and a maximum slump of five (5) inches. For fiber-reinforced concrete, a minimum slump of two (2) inches and a maximum slump of six and one-half (6½) inches are allowed.

d. Class M Concrete - shall be used for high early strength in driveway and sidewalks, when required by the project specifications or the plans. It shall meet the requirements for Class M concrete set forth in the KTC Standard Specifications.

e. Class "P" Concrete. 4000 psi 28 day for all concrete street pavement.

13.3.5 Flowable Fill. Flowable fill shall be used as required by the project specifications or the plans. It shall meet the requirements for flowable fill set forth in the KTC Standard Specifications.

13.3.6 Slipform. 4000 psi 28 day strength for slipform curb, curb and gutter and paved ditches. Recommended mix design per cubic yard is:

Limestone #57 or #67	1550 lb
Coarse River Sand	1600 lb
Cement Type 1	420 lb
Flyash Type C	144 lb
Air Entrained	5.5%
Water Reducer	22 oz

13.3.7 Batching and Mixing

a. General. The concrete shall be batched and mixed in the quantities required for immediate use. Unless otherwise specified or directed, all concrete shall be manufactured by ready-mixed methods.

b. Ready-Mixed Concrete. Ready-mixed concrete shall be manufactured and supplied in accordance with ASTM C 94, Standard Specification for ready-mixed concrete. The placement shall commence within sixty (60) minutes of batch to trucks as indicated on ticket. The interval between delivery of separate batches placed continuously in the work shall not exceed twenty (20) minutes unless otherwise permitted by the Engineer batch tickets with batch weight shown, shall be provided to the Engineer when requested.

c. Hand-Mixed Concrete. Hand mixing will not be permitted, except in case of emergency or in case of isolated small units such as pipe headwalls, and then only by permission of the Engineer.

When hand mixing is permitted, proportioning by volume will be allowed and mixing shall be done only on watertight platforms. The sand shall be spread evenly over the platform and then the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a crater and water added in an amount necessary to produce mortar of the proper consistency. The total water content shall not exceed that specified in the KTC Standard Specifications. The material on the outer portion of the crater ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced.

The coarse aggregate shall then be added to the mortar and the entire mass turned and re-turned at least six (6) times and until all coarse aggregate particles are thoroughly coated with mortar and the mixture is of a uniform color. Hand-mixed batches shall not exceed one-half (½) cubic yard.

13.3.8 Forms

a. General. All forms shall be mortar-tight, true to the dimensions, lines, and grades of the structure, and of sufficient strength to prevent appreciable deflection during placing concrete. The inside surfaces of forms shall be cleaned of all dirt, mortar, and foreign material. Forms, which will later be removed, shall be thoroughly coated with form oil, prior to use. The form oil shall be commercial quality form oil or other equivalent coating that will permit ready release of the forms and will not discolor the concrete or be detrimental to masonry coating if the surface will be coated.

Concrete shall not be deposited in forms until all work connected with constructing the forms has been completed, all materials required to be embedded in the concrete have been placed for the unit to be poured, and the Engineer has inspected forms and materials. Such work shall include removal of all dirt, chips, sawdust, water, and other foreign material from the forms.

Forms for exposed concrete surfaces shall be designed and constructed so the formed surfaces of concrete do not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Plywood forms shall be at least three-quarter (¾) inch thick and shall be placed with the face grain perpendicular to the studs or joists, unless the Contractor furnishes calculations showing that excessive deflection or stresses will not occur when the grain is parallel to the studs or joists. The clear span between supporting studs or joists shall be placed no more than twenty (20) times the thickness of the form facing.

All exposed surfaces of each element in a concrete structure shall be formed with the same forming material or with materials that produce similar surface texture, color, and appearance.
Forms for exposed surfaces shall be faced with form panels. A form panel shall be considered to be the continuous section of form facing material, unbroken by joint marks, against which concrete is placed.

Form panels for exposed surfaces shall be plywood conforming to the requirements of U.S. Product Standard PS-1 for Exterior B-B (Concrete Form) Class I Plywood or any material other than plywood that will produce a smooth uniform concrete surface substantially equal to that which would result from use of such plywood. Only form panels in good condition, free of defects, such as scars, dents, or delaminations, shall be used for exposed surfaces.

Form panels for exposed surfaces, in general, shall be furnished and placed in uniform widths of three (3) feet or more and in uniform lengths of five (5) feet or more, except where the dimensions of the member formed are less than these dimensions. Panels shall be arranged in symmetrical patterns conforming to the general lines of the structure. Form panels on each side of the panel joint shall be precisely aligned, by means of support or fasteners common to both panels, to result in a continuous, unbroken concrete plane surface.

Forms for exposed surfaces shall be constructed with chamfer strips no less than three-quarter (¾) inch by three-quarter (¾) inch, attached to prevent mortar runs and to produce smooth, straight chamfers at all sharp edges of the concrete.

Form fasteners consisting of form bolts, clamps, or other devices shall be used as necessary to prevent spreading of the forms during concrete placement. The

use of ties consisting of twisted wire loops to hold forms in position will not be permitted.

Metal ties or anchorages within the form shall be constructed to permit their removal to a depth of at least one inch from the face without injury to the concrete. All fittings or metal ties shall be of such design that upon their removal, the cavities that will remain will be the smallest possible size. Cavities, regardless of their position in the completed construction, shall be rammed and filled with mortar and the surface shall be sound, smooth, even, and uniform in color.

For narrow walls, where access to the bottom of forms is not readily attainable otherwise, the lower form boards shall be left loose so they may be removed for removal of all chips, dirt, sawdust, or other extraneous material immediately prior to placing concrete.

Forms that are intended for re-use shall be maintained in good condition to ensure accuracy of shape, strength, rigidity, water-tightness, and surface smoothness. Forms that are unsatisfactory in any respect in the opinion of the Engineer shall not be used and shall be removed immediately from the job site.

b. Removal of Falsework and Forms. In determination of the time for removal of falsework and forms, consideration shall be given to the location and character of the structure, weather, and other conditions influencing hardening of the concrete and materials used in the mixture. Removal of falsework and forms shall be done in accordance with the KTC Specifications, unless otherwise directed by the Engineer.

Forms shall be removed with care so as not to damage the surface of the concrete structure and shall be the sole responsibility of the Contractor.

13.3.9 Concrete Reinforcing

a. Protection of Steel Reinforcing. Proper care shall be used in handling and storing steel reinforcement or epoxy coated steel reinforcement to prevent bending, excessive rusting, or coating with objectionable substances. Steel reinforcement, when incorporated in the work shall be reasonably free from dirt, paint, oil, grease, loose/thick rust, and other foreign substances, and when deemed necessary, shall be cleaned to the satisfaction of the Engineer.

b. Bending Steel Reinforcing Bars. Steel reinforcing bars shall be bent cold. Bars shall be bent accurately to the dimensions and shapes shown on the Plans and to within tolerances designated in the CRSI Manual of Standard Practice. Bars shall be bent in the shop before shipment and shall not be bent in the field, unless otherwise directed by the Engineer.

c. Placing and Fastening. All steel reinforcement shall be accurately placed in positions shown and firmly held in position during placement and hardening of concrete. All steel reinforcement shall be spaced to within a tolerance of plus or minus one-half (½) inch and placed to within a tolerance of plus or minus one-quarter (¼) inch of specified clearance from the face of concrete. Dimensions shown from the face of concrete to bars are clear distances. Bar spacing is from center to center of bars. Bars shall be tied at all intersections, except where spacing is less than one foot in both directions, and then alternate intersections shall be tied. Epoxy coated steel reinforcement shall be tied with coated tie-wire.

Distances from forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Supports for holding reinforcement from contact with the forms shall be approved precast blocks composed of mortar or approved metal chairs. The tips of metal chair supports that are in contact with the surface of the concrete shall be plastic-coated steel. The steel placed in reinforced concrete slabs shall also be securely tied down to prevent any possibility of steel rising above the specified elevation during placing, vibrating, and finishing the concrete.

The top mat and bottom mat of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks shall not be permitted as separators. Reinforcement in any member shall be securely placed and then inspected and approved before the placing of concrete begins. Concrete placed in violation of this provision may be rejected.

d. Splicing. No splicing of reinforcement will be permitted, except those splices of the types and at the locations shown. Acceptable splices may include lapped splices, welded splices, mechanical splices, or other positive connection splices shown on the Plans or directed by the Engineer.

Lapped splices shall have lengths of not less than forty (40) times the nominal diameters of the reinforcement being spliced, unless otherwise shown on the Plans. Lapped splices in areas not designated on the Plans shall be made at points of low tensile stress, and the bars being spliced shall be rigidly clamped or wired together in an approved manner.

Rolls of welded steel wire mesh shall overlap each other by two (2) cells, to maintain a uniform strength, and shall be securely fastened at the ends and edges.

Welded splices shall be in conformance with the AWS Reinforcing Steel Welding Code, current edition. Bars to be welded shall be butted and welded so as to develop, in tension, at least one hundred twenty five (125) percent of the specified yield strength of the bars. Welded splices will not be permitted unless shown on the Plans or approved by the Engineer.

e. Fiber Reinforcing. When fiber reinforcing is required by the Plans or Contract, the polypropylene fibers shall meet the requirements of subsection 13.2.2c. Minimum length of fibers shall be ¾ of one (1) inch. The fibers shall be added at a rate of one (1) and ½ pounds per cubic yard after other ingredients have been placed in the mixer and prior to leaving the batch plant. Each batch delivery ticket shall indicate the amount of fibrous concrete reinforcement material per cubic yard added to each batch of concrete. Wire mesh reinforcement shall not be used in conjunction with fiber reinforcement.

13.3.10 Placing Concrete

a. General. Unless other provisions are agreed upon, the contractor shall give the Engineer 24-hour advance notice before concrete placement.

Concrete shall be delivered to its final position of placement within the time required for delivery after mixing in accordance with ASTM C 94 and within the required time interval between delivery of batches as specified in subsection 13.3.10b. Forms and reinforcement shall be moistened with water immediately before placing the concrete.

All equipment used for handling and/or placing concrete shall be such that it will accommodate concrete of the proportions and consistencies as specified. No adjustments in mixture proportions will be made to accommodate equipment that is not capable of handling concrete of specified proportions and consistencies. Equipment used to transfer concrete from truck mixers or agitators shall be of adequate design and/or dimensions to deposit concrete of the specified slump.

The method and manner of placing concrete shall avoid the segregation or separation of aggregates or displacement of reinforcement. The use of long chutes, troughs, belts, and pipes for conveying concrete from the point of delivery to the forms will be allowed only upon written permission. When such conveyers are allowed and the quality of concrete or methods of placing or working it therein are not satisfactory, the Contractor shall discontinue their use and equip his plant so that concrete will be placed in a satisfactory manner. Troughs, pipes, or chutes used as aids in placing concrete shall be arranged and used in such a manner that ingredients of the concrete are not separated.

Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that change the direction of movement. All chutes, troughs, and pipes shall be maintained clean and free from coating of hardened concrete by thoroughly flushing with water after each run or when out of operation for more than 30 minutes. Water used for flushing shall be discharged clear of concrete in place. The troughs, pipes, and chutes shall be either metal or metal-lined and shall extend as nearly as possible to the point of deposit.

Dropping concrete in excess of five (5) feet without the use of pipe or tremies, or depositing a large quantity at any point and running or working it along the forms will not be permitted. The discharge end of the pipe shall be maintained as close to the point of deposit as is feasible. Concrete placing shall entirely fill but not bulge or distort the forms or disturb their alignment.

Special care shall be exercised to fill each part of the forms by depositing concrete as near its final position as possible, to work the coarser aggregate back from the face, and to force concrete under and around reinforcing bars without displacing them. After concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on ends of projecting reinforcement.

Concrete shall be compacted either by vibration as described herein or with approved spading tools. When vibration or spading is used, it shall be

distinctly understood that formation of honeycombs, voids, or air pockets against the forms will not be allowed.

Vibration shall be internal. Vibrators shall be of types and designs capable of transmitting vibration to the concrete at frequencies to adequately consolidate the concrete. Vibration shall be of sufficient intensity and duration to cause flow or settlement of the concrete and complete compaction, but shall not be used to cause concrete to flow over long distances in the forms. The Contractor shall provide and use a sufficient number of mechanical vibrators to ensure that compaction can be started immediately after concrete has been deposited in the forms. The mechanical vibrator shall not be attached to the forms or reinforcing steel or applied to the surface of the concrete. The vibrator shall be applied to the concrete immediately after deposit of the concrete and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into angles and corners of the forms.

Vibration shall be of such duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but shall not be unduly prolonged to cause segregation or undesirable laitance at the surface of the lift being consolidated. Forms shall be designed to provide for requirements of vibration.

Concrete shall be placed in continuous horizontal layers, the thickness of which shall not exceed twelve (12) inches, unless otherwise specified for different types of structures. In any given layer, consecutive batches shall be placed and compacted before the preceding batch has taken its initial set. Each layer of concrete shall retain a rough surface in order to secure efficient bonding with the next layer. A succeeding layer placed before the underlying layer has set shall be compacted in a manner that will entirely break up and obliterate the tendency to produce a cold joint between layers.

The operations of depositing and compacting concrete shall be conducted to form a compact, dense, and impervious mass of uniform texture having smooth faces on exposed surfaces. When any section of concrete is defective, it shall be removed and satisfactorily replaced or repaired as directed.

b. Weather Limitations and Protection. Concrete shall be maintained at a minimum temperature of 45^{o}F for three calendar days after placement and at a minimum temperature of 40^{o}F for an additional four calendar days. When required, the Contractor shall submit a written outline of the method to be used for protecting concrete.

In cold weather, 40^{o}F or below, all water and/or aggregate shall be heated so the temperature of the mixed concrete shall not be less than 50^{o}F or more than 90^{o}F at the time of placement.

In hot weather, efforts shall be made to maintain temperature of the mixture below 90^{o}F. The temperature of the concrete mixture immediately before placing shall be between 50^{o}F and 90^{o}F. When the ambient air temperature is above 90^{o}F, the forms, reinforcing steel, and other surfaces that come in contact with the mixture shall be cooled to below 90^{o}F by means of a water spray or other approved methods. Excess water shall be allowed to drain or shall be removed from the forms before concrete is placed.

The Contractor shall assume all risks connected with placing concrete under these conditions and permission given by the Engineer to do the work will in no way relieve the Contractor of responsibility for proper results.

13.3.11 Curing Concrete

a. General. All surfaces that are to receive a masonry coating finish shall be wet-cured. All other concrete shall either be wet-cured or shall be cured by application of a membrane-curing compound.

b. Wet Curing. Concrete shall be cured for a period of at least seven (7) calendar days, beginning immediately after placement and finishing, by the frequent application of water to all surfaces so as to keep them continuously damp during the full seven-calendar-day curing period. Exposed concrete surfaces shall be protected from drying by application of a double thickness of wet burlap or similar material and the burlap or other approved material shall be kept continuously wet for a period of seven (7) or more calendar days.

c. Membrane Curing. The membrane forming curing compound shall not be diluted or altered prior to use, but shall be thoroughly agitated immediately prior to use. When the compound is too viscous for application, it shall be warmed in a water bath to approximately 100^{o}F prior to application.

The compound shall be uniformly applied to a surface by use of an approved pressure sprayer. Curing compound may be applied in one application provided uniform and satisfactory coverage is achieved. If the Engineer directs that two applications are required because one application is not satisfactory, then each application shall be at the rate of one (1) gallon per one hundred fifty (150) square feet or less, The first application shall be started as soon as practicable after the final finish and the second application shall be started as soon as the first application is finished. The total actual application rate shall be at least one (1) gallon per three hundred (300) square feet of actual coverage, or as specified by the manufacturer's recommendations.

Curing compound shall not be applied to construction joints, reinforcing steel, or surfaces that are to receive a masonry coating. When curing compound is applied to surfaces upon which the compound is not permitted for use, it shall be removed by sandblasting.

The curing compound shall be protected and maintained in an acceptable condition for a period of at least seven (7) calendar days. Surfaces upon which the curing compound is damaged before the end of the seven-calendar-day curing period shall be moistened and re-sprayed with curing compound.

13.3.12 Surface Finish

a. General. Unless otherwise indicated on the Plans, the surface finish that shall be applied to various parts of concrete structures shall be as follows.

b. Ordinary Surface Finish. During concrete placement, care shall be taken that methods of compaction used will result in a smooth surface of even texture free from honeycombs, water, and air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface. As soon as the concrete has set sufficiently, the forms shall be carefully removed and all metal ties, anchorages, or tie wires used within the forms to hold them to correct alignment and location shall be removed. Immediately following removal of forms, all fins and irregular projections shall be removed from all surfaces, except those not to be exposed in the completed work. On all surfaces, cavities and depression resulting from removal of form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar of the same cement and fine aggregates mixed in the same proportions as used in the class of concrete being finished. The mortar used shall not be more than 30 minutes old and the mortar patches shall be cured as specified for the structures.

After the mortar has thoroughly hardened, it shall be finished with a Carborundum stone to obtain a uniform and smooth surface, the same color and texture as in the surrounding concrete. When required, honeycomb areas shall be chipped out before pointing. All open and filled contraction and expansion joints in the completed work shall be carefully tooled and free of all mortar and concrete. The joint filler shall be exposed for the full length with clean true edges.

The objective of these requirements is to obtain smooth and even surfaces of uniform color and texture without unsightly bulges, patched areas, depressions, and other imperfections. The degree of care in building forms, the character of materials used in formwork, and the care with which concrete is placed will be factors in determining whether additional finishing of concrete will be required.

c. Masonry Coating Finish. After the concrete surface of members designated to have a Masonry Coated Finish have been inspected and accepted as having a satisfactory Ordinary Surface Finish, the concrete surface shall be cleaned of all dust, foreign matter, and form oil, and an approved Masonry Coating Finish shall be applied.

All surfaces to receive a masonry coating shall be thoroughly cleaned and free of oil, form oil, grease, dust, dirt, mud curing compound, release agents, loose patching mortar, or any other substance deleterious to bonding. The ordinary surface finish to which the masonry coating is to be applied shall be approved by the Engineer.

All surfaces to receive a masonry coating shall be checked for the presence of dust by wiping a dark cloth across the surface of the concrete. If a white powder can be seen on the dark cloth, the concrete shall be cleaned by wire brushing, grinding, or water blasting and then allowed to thoroughly dry before the masonry coating is applied. The surface will be rechecked for the presence of dust after cleaning.

All surfaces to receive a masonry coating shall be checked for the presence of oily conditions by sprinkling or fogging water on the surface of the

concrete. If the water stands in droplets without spreading out immediately, this indicates the surface is contaminated with an oily substance, and cleaning, using a detergent and water followed by thorough rinsing with water, will be required. The surface will be rechecked for the presence of oily conditions after cleaning.

All surfaces to receive a masonry coating shall be thoroughly dry before coating is applied, unless the coating manufacturer specifically recommends the surface to be wet. Surfaces will not be considered dry unless an absorbent paper pressed tightly against the surface does not show any trace of moisture.

Coating applications shall be suspended any time the ambient temperature or the temperature of the concrete does not comply with the coating manufacturer's recommendations.

Prior to application of the materials, the Contractor shall furnish the Engineer with copies of the coating material manufacturer's brochures or booklets. Masonry coating materials shall be applied in strict conformity with the manufacturer's written instructions, except that in each instance, the concrete surface shall be prepared to the satisfaction of the Engineer before application of the material is started and the material shall be applied at a uniform rate of fifty (50) square feet -- plus or minus ten (10) square feet -- per gallon.

Any portions of the coating that are not clean, uniform in color, texture, thickness, tightly bonded, or that are damaged prior to final acceptance of the Project shall be satisfactorily repaired or removed and replaced with an acceptable Finish and coating.

Care shall be exercised to secure a net uniform appearance and to prevent the coating from being dripped, sprayed, or otherwise deposited upon concrete or steel surfaces not designated to receive the coating. Any objectionable deposits or material shall be removed and the surfaces repaired to the satisfaction of the Engineer.

d. Floated Surface Finish. Horizontal surfaces not receiving Masonry Coating Finish shall be finished by placing an excess of materials in the form and removing or striking off such excess with a wooden template, forcing coarse aggregate below the mortar surface. After the concrete has been struck off as described, the surface shall be thoroughly worked and floated by hand with a wooden float and/or magnesium float leaving a fine grained, smooth-sanded surface. Sidewalks and driveways shall receive a broom finish, prior to beginning the curing process.

13.3.13 Sampling and Testing

a. Personnel. Structural concrete, such as foundations and any pour larger than five (5) cubic yards shall be sampled, and tests will be performed throughout the work at the minimal frequencies indicated or more often as necessary to determine whether concrete supplied is of the quality specified. Tests will be performed according to the procedures outlined below. The Engineer must approve the testing company prior to concrete placement. If the concrete plant is designated, the Engineer may elect to pay for samples to be taken from the same mix in order to run tests in parallel.

The technician who samples and tests concrete shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the minimum guideline for Certification of Concrete Field Testing Technicians, Grade I in accordance with the American Concrete Institute.

b. Sampling Fresh Concrete. Concrete shall be sampled in accordance with the procedures set forth in ASTM C 172, Standard Specification for Sampling Freshly Mixed Concrete.

c. Slump Test. Slump tests shall be performed in accordance with the procedures set forth in ASTM C 143, Standard Test Method for Slump of Portland Cement Concrete.

d. Air Content. The air content shall be determined by the volumetric or pressure methods in accordance with the procedures set forth in ASTM C 173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method, or ASTM C 231, Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method.

e. Test Cylinders. Concrete test cylinders shall be made and cured in accordance with the procedures set forth in ASTM C 31, Standard Practice for Making and Curing Concrete Test Specimens in the Field. Unless otherwise specified, four test cylinders shall be molded for each set. Cylinders used for determining form removal time shall be stored at the site as near to the concrete being represented as possible.

f. Compressive Strength Tests. The compressive strength of test cylinders shall be determined in accordance with the procedures set forth in ASTM C 39, Standard Test for Compressive Strength of Cylindrical Concrete Specimens.

g. Frequency of Tests. Unless otherwise directed by the Engineer, a minimum of one (1) set of test cylinders shall be made daily for each fifty (50) cubic yards, or portion thereof, placed in each structure. One cylinder shall be tested at seven (7) days and two (2) cylinders shall be tested at twenty-eight (28) days to check the adequacy of the concrete mix.

Slump and air content tests shall be made at the time of concrete placement as often as is necessary for control checks and acceptance purposes, and always when compressive strength specimens are made. If the measured slump or air content falls outside the specified limits, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, the concrete shall be considered to have failed the requirements of these Specifications. The first cubic yard and last one-quarter (¼) cubic yard discharged from the mixer are exempt from the slump and air content requirements of these Specifications.

13.4 CONCRETE MIX DESIGNS AND PLACING METHODS

13.4.1 Purpose. The purpose of this section is to allow the Contractor and ready mix supplier to design mixes for weather conditions, subgrade conditions, placing, finishing, and curing operations in accordance with ACI or KTC that may be used with approval of the Engineer.

13.4.2 Practices to Prevent Scaling. The Contractor shall follow the procedures listed below:

a. Use of Air-Entrained Concrete. To prevent scaling, the use of air-entrained concrete is required. Severe exposures require air contents of six (6) to seven (7) percent in freshly mixed concrete made with three-quarter (¾) inch or one (1) inch aggregate. In moderate exposures where deicing salts will not be used, four (4) to six (6) percent air will be sufficient. Air-entrained concrete having a low water-cement ratio and moderate slump -- up to five (5) inches -- helps produce a strong wear-resistant surface.

b. Deicing. DO NOT use deicing salts, such as calcium or sodium chloride, on new or recently placed concrete. Use clean sand for traction. Never use ammonium sulfate or ammonium nitrate as a deicer; these are chemically aggressive and destroy concrete surfaces. Poor drainage, which permits water or salt and water to stand on the surface for extended periods of time, greatly increases the severity of the exposure and causes scaling. (This is often noticed in gutters and sidewalks where the snow from plowing keeps the surface wet for long periods of time.) Light applications of salts can be more damaging than heavy applications; even salts carried on cars may cause severe scaling of newly placed driveways.

c. Curing. Provide proper curing by using liquid membrane curing compound or by covering the surface of freshly placed slab with wet burlap. Curing insures proper combination of cement with water, known as hydration, which allows the concrete to achieve its highest potential strength.

d. Finishing. DO NOT perform any finishing operations with water present on the surface. Bull floating must promptly follow initial screeding. (Do not use a jitterbug or vibrating screed to work up an excessive layer of mortar on the surface.)

e. Winter Work. Protect concrete from the harsh winter environment. It is important to protect young concrete from becoming saturated with water prior to freeze-and-thaw cycles of the winter months. Seal the surface with surface sealer specifically designed for use on slabs on grade.

13.4.3 Practices to Minimize Cracking. The Contractor shall follow the procedures listed below:

a. Subgrade and Formwork. All topsoil soft spots shall be removed. Regardless of its type, the soil beneath the slab shall be compacted soil or granular fill, well compacted by rolling, vibrating or tamping. The slab and, therefore, the subgrade shall be sloped for proper drainage. Smooth, level subgrades help prevent cracking. All formwork must be constructed and braced so that it can withstand the pressure of the concrete without movement. Immediately prior to concrete placement, dampen the subgrade, formwork, and the reinforcement.

b. Concrete. In general, use concrete with a moderate slump -- not over five (5) inches. Do not re-temp. If higher slump -- up to seven (7) inches -- is to be used, proportions will have to be changed and special mixtures developed to avoid excessive bleeding, segregation and low strength. Specify air-

entrained concrete for outdoor slabs subjected to freezing weather.

c. Finishing. DO NOT perform finishing operations with water present on the surface. Bull floating must promptly follow initial screeding. For better traction on exterior surfaces use a broom finish. If evaporation is excessive, control it by some means to avoid plastic shrinkage cracking. Cover the concrete with wet burlap or polyethylene sheets in between finishing operations if conditions are severe.

d. Curing. Start curing as soon as possible. Spray the surface with liquid membrane curing compound or cover it with damp burlap and keep it moist for at least three (3) days. A second application of curing compound the next day is a good quality assurance step.

e. Joints. Provisions for contraction or expansion movements due to temperature and/or moisture change shall be provided with construction of control or contraction joints by sawing, forming or tooling a groove about one-quarter (¼) inch the thickness of the slab, no further apart than thirty (30) times the thickness. Often, closer spacing of control joints will be necessary to avoid long thin areas. The length of an area shall not exceed about one and one-half (1.5) times the width. Isolation joints should be provided whenever restriction to freedom of either vertical or horizontal movement is anticipated, such as where floors meet walls, columns, or footings. These are full-depth joints and are constructed by inserting a barrier of some type to prevent bond between the slab and the other elements.

f. Cover Over Reinforcement. Cracks in reinforced concrete caused by expansion of rust on reinforcing steel should be prevented by providing sufficient concrete cover -- at least two (2) inches -- to keep salt and moisture from contacting the steel.

13.4.4 Cold Weather Concreting. The Contractor should understand and follow the procedures listed below:

a**.** Cold weather concreting can be very successful, but the Contractor, ready mix supplier and Engineer must understand the special requirements.

b. Concrete properly placed in cold weather will have higher long-term strength than concrete placed in hot weather. New technology allows concrete mix design to be a major help in overcoming cold weather problems.

c. Cold weather is defined by ACI 306 as a period when for more than three (3) successive days the main daily temperatures drops below 40^{o}F. Normal concreting practices can be resumed once the ambient temperature is above 50^{o}F for more than half a day.

d. Concrete gains very little strength at low temperatures. Concrete must be protected until the process of hydration has reduced saturation of the concrete. This amount of hydration has usually occurred when concrete reaches 500 psi.

e. Concrete shall not be placed on frozen ground. Subgrade shall be covered with straw or other insulation material to prevent the ground from freezing until concrete can be placed.

f. The ready mix supplier should be allowed to produce a special mix design for cold weather concreting for temperatures down to 20^{o}F in accordance with ACI.

g. The following procedures should be followed when placing concrete:

1. Place concrete at a low slump – five (5) inches maximum.

2. Do not add water to mix at the job site. The resulting in bleed water will increase setting time, make a greater chance for laminated surfaces, reduce air entrainment, and float soft non-durable aggregate to the surface.

3. When curing in cold weather it is better to use covering than spray-on curing compounds. Insulation, such as a thick blanket of straw, or even better, insulated curing blanket without artificial heat is often sufficient protection for slabs on ground. The concrete hydration process produces heat; by containing this heat with insulation, concrete is protected for several days. After three (3) days, concrete heat of hydration is lost and all coverings should be removed and concrete allowed to air dry. It is a frequent mistake to keep concrete covered for more than three (3) days. Freezing temperatures can easily damage concrete in a saturated condition. *Remember to uncover after three (3) days and let concrete start to air dry.*