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SECTION 3100

CONCRETE STRUCTURES

3101 GENERAL

3101.1 Scope

- A. This section shall govern the performance of all work necessary for construction of cast-in-place concrete structures for inlets, manholes, junction boxes, head walls, and incidental structures.
- B. The Contractor shall guarantee that concrete of the specified compressive strength is incorporated in the structures and that the responsibility for producing the required grades of concrete is assumed by the Contractor. Should the average strengths shown by test cylinders fall below the strengths required, the Engineer may require any or all of the following changes: amount of cement; grading of aggregate, or ratio of the water to the cement used. If the tests disclose that the strength of the concrete is insufficient for the structure as built, the Engineer may condemn the part of any structure in which concrete of insufficient strength has been placed and the Contractor, at his cost, shall remove and replace such concrete with concrete meeting these specifications.

3101.2 Abbreviations

Wherever the words, forms, or phrases herein defined or pronouns used in their stead occur in these specifications, in the contract or in the Advertisement of any document or instrument herein contemplated or to which these specifications apply, the intent and mean shall be interpreted as defined in the General Conditions of the Construction Contract.

3101.3 Submittals

- A. Before construction, the Contractor shall submit to the Engineer for review drawings showing construction and installation details.
- B. All material furnished under this contract shall be in accordance with the drawings and these specifications.

3102 MATERIALS

3102.1 Cement

- A. All cement used in the work shall be a standard brand of portland cement and shall comply with the cement ASTM C150 Standard Specifications for "Air-Entraining Portland Cement". The cement shall be Type I.
- B. All cement hauled to the job shall be in original unopened containers, bags or sacks showing the brand name of the manufacturer. Only one brand of cement shall be used in any individual structure. Cement reclaimed by cleaning bags or cement that has leaked from containers shall not be used. Cement shall be used in the sequence of shipments received, unless otherwise directed.

- C. Different brands, grades or types of cement shall be stored separately. All cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, in a suitable weather tight building that will protect it from dampness and deterioration. Packages of cement which have become partially set, or contain any lumps or caked cement shall be rejected; and, in no instance will any portion of a bag of damaged or faulty cement be used.

3102.2 Aggregates

- A. All aggregates used shall conform to the requirements of ASTM C33 Specifications for "Concrete Aggregate", unless otherwise indicated on the drawings or directed by the Engineer. Aggregate shall be classified and separated into fine aggregate and coarse aggregate, as defined below:
1. Fine aggregate: Fine aggregate for concrete and mortar shall be sand composed of clean, hard, durable, uncoated grains, free from conglomerate, soft or flaky particles, salt, alkali, or loam. Fine aggregate shall be free from injurious organic impurities, deleterious substances and in no case will aggregate containing lumps of frozen material be used. The aggregate shall be well graded from coarse to fine and shall conform to the following laboratory sieve analysis:

FINE AGGREGATE

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 Inch*	100%
No. 4	95 -100%
No. 16	45-85%
No. 50	5-30%
No. 100	0-7%

MORTAR SAND

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 8	100%
No. 50	15-40%
No. 100	0-10%

* - Stone screenings shall not be used for fine aggregate.

2. Coarse aggregate: Coarse aggregate for portland cement concrete shall be crushed stone obtained from clean, tough, hard, sound, durable rock consisting of angular fragments of uniform quality throughout, or gravel consisting of clean, tough, durable pebbles, free from clay, coatings of any character, disintegrated or soft pieces, conglomerates, mud balls, sticks, salt, alkali, or vegetable matter. Coarse aggregate shall be free of injurious, deleterious substances and shall be well graded from coarse to fine conforming to the following laboratory sieve analysis:

COARSE AGGREGATE GRADATION

<u>Sieve Size</u>	<u>Percent Passing</u>
1-1/2 Inch	100%
1 Inch.....	90-100%
2 Inch.....	25-60%
No. 4.....	0-10%

- B. Sampling and testing: Sampling and testing shall be in accordance with the latest revision of the AASHTO Methods.

Sampling.....	T-2
Sieve Analysis	T-27
Material Passing No. 200	T-11
Organic Impurities.....	T-21
Clay Lumps and Friable Particles	T-112 modified
Coal and Lignite	T-113
Mortar and Tensile Strength.....	T-35

- C. Storage: Aggregate shall be stored in a manner that will allow good drainage and will insure that the aggregate is kept free of foreign matter. Sites for stock piles shall be graded and cleaned prior to storing materials. Aggregate from different sources shall be stored in separate stock piles. Care shall be taken to prevent segregation; material which becomes segregated to the extent that it no longer satisfies the grading requirements shall be combined to satisfy such requirements before being used in concrete.

3102.3 Water

Water used in mixing concrete shall be clean, clear, and free from deleterious amounts of acids, alkalis, oil, salt, organic materials or any other substances injurious to the finished concrete. Water from City water system may be accepted without being tested. Water from doubtful sources shall not be used until tested and approved. Testing of water shall be in accordance with AASHTO Method T-26.

3102.4 Admixtures

- A. Air-entrained concrete shall be used in all concrete work unless otherwise specified in the plans. Either an air-entraining cement produced at the mill or an air-entraining agent added at the batching plant may be used. When necessary to increase the air content of a mill-produced air-entraining cement concrete, additional air-entraining admixture identical with that already in the cement shall be added at the plant. Air-entraining admixtures shall conform to ASTM Specifications C-260.
- B. Set-control admixture: Set controlling agents shall conform to ASTM C 494, as follows:
1. Type A, Water Reducing
 2. Type B, Retarding.
 3. Type C, Accelerating.

4. Type D, Water-Reducing and Retarding.
 5. Type E, Water-Reducing and Accelerating.
- C. Other admixtures: Other admixtures, unless specifically called for, shall be used only with the written approval of the Engineer and shall be used in accordance with the manufacturer's instructions and recommendations.

3102.5 Fly Ash

Concrete materials shall conform to ODOT Specification Section 701, except that fly ash shall not be used to replace cement in the mix design.

3102.6 Concrete Mixes

Concrete shall conform to the requirements of ODOT Section 701.01 (a), except for the references to fly ash. Concrete shall contain no more than six (6) gallons of water per sack of cement, including water in the aggregates. Concrete shall have a minimum of six (6) sacks of cement per cubic yard of concrete. Class AA concrete with a 28-day compressive strength of 4,000 psi shall be used. The air content shall be 4-6 percent. The exact proportions of the ingredients shall be determined by trial batches, to secure a maximum density plastic mix of satisfactory workability acceptable to the Engineer. The slump shall be not less than two (2) nor more than three (3) inches for vibrated concrete, with the exception of concrete for thin reinforced walls and other narrow vertical sections in which case the slump shall be not less than three (3) inches nor more than four (4) inches. The proportions shall be such as will produce a mixture readily workable into the corners and angles of the forms, and around reinforcement, but without permitting the materials to segregate or free water to collect on the surface.

3102.7 Reinforcing Steel

- A. Reinforcing bars (rebar): All reinforcing bars shall be rolled from new billets and shall conform to the ASTM A615 Specifications for Billet-Steel Bars for Concrete Reinforcement, and shall be of the Grade 60 unless otherwise specified. Unless otherwise shown, all reinforcing bars shall be deformed and shall conform to the requirements of the ASTM A615 specifications for minimum reinforcement. The deformed bars used shall have a net sectional area at all points equivalent to that of plain bars of equal nominal size. Twisted steel bars shall not be used.
- B. Supports for reinforcement: Reinforcement supports shall be bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcements in place.
 1. Wire bar type supports shall comply with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, or concrete block.
 2. Sand plates or horizontal runners shall be used where base material will not support chair legs for slabs on grade.
 3. Either hot-dip galvanized, plastic protected or stainless steel protected legs shall be used for exposed-to-view concrete surfaces, where legs of supports are in contact with forms.

4. Tie wire: Tie wire sixteen (16) gauge minimum and in sufficient quantity to hold reinforcement accurately in place during concrete placement operations.
 5. Welded steel wire fabric: Fabric shall conform to the requirements of ASTM A185 and shall be of the size and space opening as designated on the plans.
- C. Fabrication:
1. General: Reinforcing bars shall be fabricated conforming to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice." In case of fabricating errors, the Contractor shall not rebend or straighten reinforcement in a manner that will injure or weaken the material.
 2. Unacceptable materials: Reinforcement with any of the following defects will not be permitted in the work:
 - a. Bar lengths, depths and bends exceeding specified fabrication tolerances.
 - b. Bend or kinds not indicated on drawings or final shop drawings.
 - c. Bars with reduced cross-section due to excessive rusting or other cause.
 3. Identification: Reinforcing bars shall be tied in bundles and tag with weatherproof tags showing shop drawing numbers.

3102.8 Forms

- A. Forms for exposed concrete: Form work for exposed concrete surfaces shall be high-density overlay plyform Class I or II. Panels shall be APA grade-trade-marked and meet requirements of the latest edition of U.S. Product Standard PSI. Overlay shall not stain the surface of the architectural concrete. Full sheet sizes shall be used to minimize number of joints and to conform to joint system shown on drawings. Form material shall be of sufficient thickness to withstand pressure of newly placed concrete without bow or deflection (minimum 3/4 inch).
- B. Forms for unexposed concrete: Concrete surfaces, which will be unexposed in the finished structure, shall be formed with plywood, lumber, metal, or other acceptable material. Lumber shall be dressed on at least 2 edges and 1 side for tight fit, tongue and grooved, free from loose knots and of such moisture content as to prevent free absorption of moisture.
- C. Form coatings : Commercial formulation form coating compounds shall be provided will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. Release agent shall be used in strict accordance with manufacturer's recommendations.
- D. Vinyl foam tape: Vinyl foam tape shall be 3/4" x 1/8" adhesive backed closed cell tape.
- E. Form accessories: Only form ties, anchors, and hangers of sufficient strength to completely resist displacement of forms due to construction loads and the depositing of

concrete shall be used. Tie-and-spreader type form ties designed so that no metal will be within one inch of any surface when forms are removed shall be used. Where concrete surfaces are exposed to view, the Contractor shall not use form ties which, when removed, will leave a depression larger than one (1) inch in diameter. The Contractor shall use water seal ties in concrete exposed to hydrostatic pressure which conform to ACI 301 and 347.

1. Metal inserts shall be used for anchorages of materials or equipment to concrete construction, not supplied by other trades and as required for the work. Threaded inserts of malleable cast iron, furnished complete with full-depth bolts to the proper size shall be used unless otherwise noted.
 2. Adjustable wedge inserts of malleable cast iron, complete with bolts, nuts and washers, and bolt size, shall be used.
- F. Screen chairs: Metal or wood screen chairs shall not be used.
- G. Corner chamfer: Chamfers shall be mill run white pine solid material or preformed PVC at all exposed corners of columns, walls and beams.

3102.9 Concrete Curing Compounds

- A. Absorptive cover: Burlap cloth shall be made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 3.
- B. Moisture-retaining cover: Moisture retaining covers shall be one of the following, complying with ASTM C 171.
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- C. Membrane-forming curing compound: Membrane forming curing compounds shall conform to ASTM C 309, Type I with white fugitive dye unless other type acceptable to the Engineer.
- D. Liquid curing, sealing, hardening compound: The following list of materials is not intended to be a complete list of materials and work required but a guide to the type, quality, and finish required for various surfaces. The list of products below is intended only to set a standard of quality.

<u>Product</u>	<u>Manufacturer</u>
Euco cure	Euclid Chemical Co.
Masterseal	Master Builders
Polyclear	Upco Chemical/USM Corp.
Dress & Seal	L & M Construction Chemicals
Triple Seal	Protex Industries
Clear Bond	Guardian Chemical Co.
Cure & Seal	Symons Corporation

Kure-N-Seal

Sonneborn Building Products

E. Special notes:

1. All concrete which is not designated on the plans as "architectural concrete" or which does not receive an applied coating or flooring shall be cured with pigmented resin based curing compound.
2. Curing compounds containing oil or wax shall not be used. Allow concrete to thoroughly dry following rain. Use form release agents which will not transfer to the concrete.

3102.10 Water Stops

Provide 3-1/4" polyvinyl chloride (PVC) water stops at construction joints and other joints of type shown on drawings.

3102.11 Preformed Expansion Joint Fillers

Preformed expansion joint fillers shall conform ASTM D-1751, and be non-extruding and resilient type.

3102.12 Radius Former

Radius former shall be PVC.

3103 QUALITY ASSURANCE

3103.1 Submittals

- A. The Contractor shall furnish, to the Engineer, the certificates and test results described below. The Engineer may require additional tests and/or verifications to insure the quality of concrete produced is as specified.
- B. Concrete:
 1. Mix design: Provide mix design formula for the materials proposed for use in making concrete using the absolute volume method. The design should include material sources, specific gravities and other pertinent data.
 2. Strength: Prior to placing any concrete, the compressive strength shall be verified by making three test cylinders using the proposed mix designs. The cylinders will be tested and the results provided with the mix design submittal.
- C. Reinforcing steel:
 1. Comply with requirements of the latest edition of the following codes and standards, except as herein modified:

- a. American Welding Society, AWS D1.4-1979, "Standard Welding Code - Reinforcing Steel."
 - b. Concrete Reinforcing Steel Institute, "Recommended Practice for Placing Reinforcing Bars."
 - c. Concrete Reinforcing Steel Institute, "Manual of Standard Practice for Reinforced Concrete Construction."
 - d. American Concrete Institute, ACI 318, "Building Code Requirements for Reinforced Concrete."
 - e. ASTM A615: "Specifications for Deformed and Plain Billet-Steel Bars for concrete Reinforcement."
 - f. ACI 315: "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
 - g. ASTM A185: "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement".
- D. Formwork: Unless otherwise shown or specified, design, construct, erect, maintain, and remove forms and related structures for cast-in-place concrete work in compliance with the following:
1. ACI 347: Recommended Practice for Concrete Form work.
 2. USPS PSI: Product Standard for Softwood Plywood Construction and Industrial.
- E. Allowable tolerances:
1. Construct form work to provide completed cast-in-place concrete surfaces complying with the tolerances specified in ACI 374.
 2. Before concrete placement, check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.
 3. During concrete placement, check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.

3103.2 Construction Methods

- A. Concrete mixing:
1. Experimental concrete mixes:
 - a. The Contractor shall make experimental mixes prior to the placing of the concrete and at any time during the progress of the work when necessary to demonstrate that the concrete will meet these specifications. Materials for

making experimental mixes shall be furnished by the Contractor and these materials shall be identical with those intended for use in the work. The cost of the materials, as well as the costs of crushing test specimens made from the experimental mix, shall be borne by the Contractor and shall be included in the price bid for concrete.

2. On-site mixing:

- a. **General:** The Contractor shall mix concrete in a batch mixer conforming to requirements of the mixer manufacturer's Bureau of the Associated General Contractors of America. Mixer shall bear the manufacturer's rating plate indicating rated capacity and recommended revolutions per minute; operate mixer in accordance with these recommendations; and use only mixers that are equipped with a suitable charging hopper, water storage tank, water measuring device and are capable of thoroughly mixing the concrete into a uniform mass within the specified mixing time and of discharging the mix without segregation.
- b. **Admixtures:** After approved for use, The Contractor shall dispense liquid admixtures by means of an automatic dispenser or similar metering device; weigh or measure by volume powdered admixtures, as recommended by the manufacturer; accurately measure all admixtures to within plus or minus 5 percent; and shall provide suitable agitating equipment to insure uniform distribution of ingredients.
- c. **Mixing:** The Contractor shall charge batch into the mixer so that some water will enter in advance of the cement and aggregates; allow water to flow into the mixer until the end of the first 25 percent of the specified mixing time; provide controls to insure that the batch cannot be discharged until the specified mixing time has elapsed; provide controls to insure that no additional water may be added during mixing; and discharge the entire batch before recharging.
- d. **Mixing time:** The Contractor shall mix each batch of 2 cubic yards or less for not less than 1-1/2 minutes, and not more than 5 minutes after all ingredients are in the mixer before any part of the batch is released; increase mixing time by 15 seconds for each additional cubic yard or fraction thereof; and not exceed 30 minutes total elapsed time between intermingling of damp aggregates and cement to the discharge of the completed mix into the forms.
- e. **Maintenance:** The Contractor shall keep mixer clean and replace mixer pick-up and throw over blades when they have lost 10 percent of their original depth.
- f. **Identification:** The Contractor shall provide a batch ticket for each batch discharged and used in the work, indicating the project identification name and number, date, mix type, mix time, quantity and amount of water introduced.
- g. **Retempering:** The Contractor shall mix concrete only in quantities for immediate use. Discard concrete which has set; do not retemper. Adding water to the mix at the job site shall not be permitted unless prior approval is obtained from the Engineer.

3. Ready-mix concrete: The Contractor shall comply with the requirements of ASTM C94, and as herein specified, provided quantity and rate of delivery will permit unrestricted progress of the work in accordance with the placement schedule. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required. Proposed changes in mixing procedures shall be accepted by the Engineer before implementation. All mixer trucks shall be equipped with water meters. Additional water shall be added at the job site only with the specific permission of the Engineer. Plant equipment and facilities should conform to National Ready-Mix Concrete Association "Check-list for Certification of Ready-Mixed Concrete Production Facilities".

4. Consistency:

a. All reinforced concrete which is required to be spaded or puddled in forms or around reinforcing steel shall be of such consistency that:

(1) All aggregates will float uniformly throughout the mass without settling or segregating.

(2) When dropped directly from the discharge chute of the mixer, the concrete will flatten out at the center of the pile but will stand up at the edges, the piling spreading from internal expansion and not by flowing.

(3) The concrete will flow sluggishly when tamped or spaded.

(4) The concrete can be readily puddled into corners and angles of forms and around reinforcing steel,

(5) The concrete can be readily spaded to the bottom of the placement or to a depth of several feet at any time within thirty (30) minutes after placing.

b. A desirable consistency is one which results in a very slight accumulation of water at the top of a layer several feet in thickness, but without segregation or accumulation of laitance. If, through accident, intention or error in mixing, any concrete shall, in the opinion of the Engineer, vary materially from the consistency specified, such concrete shall not be incorporated in the work but shall be discharged as waste material.

B. Cast-in-place concrete:

1. Form work design:

a. The Contractor shall design, erect, support, brace and maintain form work so that it will safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. The Contractor shall carry vertical and lateral loads to ground by a form work system and in-place construction that has attained adequate strength for that purpose. The Contractor shall construct form work so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

- b. The Contractor shall design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on Form work, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
 - c. The Contractor shall provide shores and struts with positive means of adjustment capable of taking up form work settlement during concrete placing operations, using wedges or jacks or a combination thereof and provide trussed supports when adequate foundations for shores and struts cannot be secured.
 - d. The Contractor shall support form facing materials by structural members spaced sufficiently close to prevent deflection; fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances; and provide camber in form work as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads for long-span members without intermediate supports.
 - e. The Contractor shall provide temporary openings in wall forms, column forms and at other locations necessary to permit inspection and clean-out.
 - f. The Contractor shall design form work to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
 - g. The Contractor shall provide form work sufficiently tight to prevent leakage of cement paste during concrete placement; solidly butt joints and provide backup material at joints as required to prevent leakage and fins; seal form joints with foam tape or other demonstrated effective means; and provide a means to seal the bottom of forms at construction joints such as foam tape or other gasket devices.
2. Placing forms:
- a. Concrete forming shall conform to ACI Code 347, to the exact sizes, shapes, lines and dimensions shown, and as required to obtain accurate alignment, location, grades, level and plumb work in finished structures; provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking screeds, bulkheads, anchorages and inserts, and other features required; and use select materials to obtain required finishes.
 - b. Forms shall be installed so removal without hammering or prying against concrete surfaces. Crush plates or wrecking plates shall be installed where stripping may damage cast concrete surfaces. Top forms for inclined surfaces shall be installed where the slope is too steep or place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like to prevent swelling and assure ease of removal.
 - c. The Contractor shall provide temporary openings where interior area of form work is inaccessible for clean out, for inspection before concrete placement, and for placement of concrete. The Contractor shall brace temporary closures and set

tightly to forms to prevent loss of concrete mortar and locate temporary openings on forms in as inconspicuous location as possible, consistent with project requirements.

- d. The Contractor shall form intersecting planes to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.
 - e. The Contractor shall provide openings in forms to accommodate other work, including mechanical and electrical work; and accurately place and securely support items required to be built into the form.
 - f. The material to be used in the forms for exposed surfaces shall be sized and dressed lumber or metal in which all bolt and rivet heads are countersunk. In either case, a plain, smooth surface of the desired contour shall be obtained.
 - g. Undressed lumber may be used for backing or other unexposed surfaces, except inside faces of conduits.
 - h. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed.
 - i. Temporary openings where interior area of form work is inaccessible shall be used for clean out, for inspection before concrete placement, and for placement of concrete. Temporary closures shall be braced and set tightly to forms to prevent loss of concrete mortar. Temporary openings shall be located on forms in as inconspicuous location as possible, consistent with project requirements.
 - j. Intersecting planes shall be formed to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.
 - k. Provide openings in forms to accommodate other work, including mechanical and electrical work. Accurately place and securely support items required to be built into the form.
3. Falsework:
- a. The Contractor shall erect falsework and support, brace, and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures; and construct falsework so that adjustments can be made for take-up and settlement.
 - b. The Contractor shall provide wedges, jacks, or camber strips to facilitate vertical adjustments; carefully inspect falsework and form work during and after concrete placement operations to determine abnormal deflection or signs of failure; and make necessary adjustments to produce work of required dimensions.
4. Forms for exposed concrete:

- a. The Contractor shall drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes and not splinter forms by driving ties through improperly prepared holes.
 - b. The Contractor shall not use metal cover plates for patching holes or defects in forms.
 - c. The Contractor shall provide sharp, clean corners at intersecting planes, without visible edges or offsets; and back joints with extra studs or girts to maintain true, square intersections.
 - d. The Contractor shall use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. The Contractor shall not use narrow strips of form material which will produce a bow.
 - e. The Contractor shall assemble forms to be readily removed without damage to exposed concrete surfaces.
 - f. The Contractor shall form molding shapes, recesses and projections with smooth-finish materials, and install forms with sealed joints to prevent displacement.
5. Corner treatment:
- a. The Contractor shall form exposed corners to produce square, smooth, solid, unbroken lines, except as other wise shown.
 - b. The Contractor shall form chamfers with 3/4" x 3/4" strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. The Contractor shall extend terminal edges to required limit and miter chamfer strips at changes in direction.
 - c. Unexposed corners may be formed either square or chamfered.
6. Control joints:
- a. Concrete shall be placed continuously so that the unit will be monolithic in construction. Fresh concrete may be placed against adjoining units provided the set concrete is sufficiently hard not to be injured thereby. Joints not indicated shall be made and located to least impair strength and appearance of the structure. Concrete for walls shall be in place at least 2 hours before concreting beams, girders, or slabs thereon. Beams, brackets, and haunches shall be considered as part of the floor system and shall be placed monolithically therewith. Placement of concrete shall be at such rate that surfaces of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon. Girders, beams, and slabs shall be placed in one operation. In walls having door and window openings, individual lifts shall terminate at top and bottom of opening. Other lifts shall terminate at such levels as are indicated or as to conform to structural requirements or architectural details, or both, as directed.

7. Water stops: The Contractor shall provide water stops in construction joints as shown on the drawings. Install water stops to form a continuous diaphragm in each joint; make provisions to support and protect water stops during the progress of the work; fabricate field joints in water stops in accordance with manufacturer's print instructions; and protect water stop material from damage where it protrudes from any point. No wood device of any kind used to separate forms shall be permitted to remain in the finished work.
8. Provision for other trades: The Contractor shall provide openings in concrete form work to accommodate work of other trades, including those under separate prime contracts (if any). Size and location of openings, recesses and chases are the responsibility of the trade requiring such items. The Contractor shall accurately place and securely support items to be built into forms.
9. Cleaning and tightening: The Contractor shall thoroughly clean forms and adjacent surfaces to receive concrete; remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed; and retighten forms immediately after concrete placement as required to eliminate mortar leaks.
10. Form coatings:
 - a. The Contractor shall coat form contact surfaces with form-coating compound before reinforcement is placed; keep excess form coating from accumulating in forms or to come into contact with surface which will be bonded to fresh concrete; and apply in compliance with manufacturer's instructions.
 - b. The Contractor shall coat steel forms with a non-staining, rust-preventive form oil or otherwise protect against rusting. Rust-stained steel form work is not acceptable.
11. Installation of embedded items:
 - a. General: The Contractor shall set and build into the wood anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete and use setting drawings, diagrams, instructions and directions provided by suppliers of the items to be attached thereto.
 - b. Edge forms and screen strips for slabs: The Contractor shall set edge forms or bulkheads and intermediate screen strips for slabs to obtain required elevations and contours in the finished slab surface and provide and secure units to support types of screen required.
12. Shores and supports:
 - a. The Contractor shall comply with ACI 347 for shoring and reshoring, and as herein specified.
 - b. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete.

- c. Locate and provide adequate reshoring to safely support the work without excessive stress or deflection.

13. Placing reinforcement:

- a. All reinforcement, when placed, shall be free from mill scale, loose or thick rust, dirt, paint, oil or grease, and shall present a clean surface. Storage of material shall be on pallets with tarpaulin coverings to prevent rust and scale.
- b. Bends and splices shall be accurately and neatly performed, and shall conform to the ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures and the CRSI Handbook.
- c. All reinforcing shall be placed in the exact position shown on the plans and shall be held firmly in position by means of metal chairs, bolsters, spacers, hangers or other accepted supports, such as wiring the bars together at intersections with accepted wire ties in order that the reinforcement will not be displaced during the depositing and compacting of the concrete. Tie wires ends shall be turned away from the exposed surfaces.
- d. When the concrete surface will be exposed to the weather in the finished structure or where rust would impair the appearance, the portions of all accessories in contact with the form work shall be galvanized steel or plastic.
- e. The placing and fastening of reinforcement in each section of the work shall be accepted by the Engineer before any concrete is deposited in the section.
- f. Care shall be taken not to disturb the reinforcement after the concrete has taken its initial set.
- g. Reinforcing steel shall be overlapped to fully develop the reinforcing.
- h. Splicing bars shall be performed in accordance with ACI Code 318 for minimum lap. Splice locations shall be at mid-span on all top bars and at the supports for all bottom bars.
- i. The minimum coverages for reinforcement shall be maintained as stated in ACI Code 318.

14. Anchors and inserts:

- a. Anchor bolts, castings, steel shapes, conduit, sleeves, masonry anchorage, and other materials that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.
- b. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be installed on the concrete side of the form or template. A second nut shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

- c. Inserts shall be clean when installed. After installation, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.
- d. The Contractor shall coordinate the installation of all anchors and inserts during forming operations. Prior to actual placement of concrete, all insert and anchor locations shall be rechecked to assure proper vertical and horizontal alignment.
- e. Care shall be taken during placement operations so as not to alter the location of any anchors or inserts.
- f. After screening operations are complete, the vertical and horizontal alignment shall be rechecked to assure the proper location of anchors and inserts.
- g. In the event the alignment is improper, the Contractor shall revise, repair, modify, or replace any anchor or insert which is improperly embedded. The cost of such work shall be borne by the Contractor.

15. Pre-placement inspection:

- a. Before placing concrete, inspect and complete the form work installation, reinforcing steel, preformed joint fillers, vapor barriers, water stops and items to be embedded or cast-in. Notify other crafts involved in ample time to permit the installation of their work; cooperate with other trades in setting such work, as required.
- b. Thoroughly wet the forms immediately before placing concrete, as required where form coatings are not used. Where coating is used, the Contractor shall with a brush or spray coating, covering the form evenly without excess drip. Form oil which causes softening or permanent staining of the concrete shall not be used.
- c. Soil at bottom of foundation systems is subject to testing for soil bearing value by the testing laboratory, as directed by the Engineer. Place concrete immediately after approval of foundation excavations. Excavate and backfill as necessary to complete the concrete work. Place concrete on subgrades that are well compacted to level and true grade. Before concrete is placed in areas between slabs on grade previously placed, recheck compaction of subgrade and if necessary, re-compact to avoid settlement of slabs at joints. Seal extremely porous subgrades in a manner approved by the Engineer. Remove all ice, debris, and excess water from subgrades.
- d. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.
- e. The installation of anchors, inserts, and sleeves for electrical, mechanical plumbing, heating, ventilating and air-conditioning work is subject to the inspection and approval of the supervisors of the particular trades involved. Finish voids in sleeves and inserts temporarily with readily removable material.
- f. Notify the Engineer 24 hours before placing concrete.

16. Concrete conveying:

- a. General: Handle concrete from the mixer to the place of final deposit as rapidly as practicable and in a manner which will assure that the specified quality of the concrete is obtained.
- b. Equipment: Provide conveying equipment of proper size and design to insure a continuous flow of concrete to a delivery end. Conveying equipment will be subject to the Engineer's approval.
- c. Truck mixers, agitators and non-agitating units and their manner of operation shall conform to the applicable requirements of ASTM C 94.
- d. Belt conveyors: Provide conveyors and discharge apparatus of a type which will not cause segregation. Discharge long runs into a hopper.
- e. Chutes: Provide metal or metal lined chutes and install to a slope not exceeding 1 vertical to 3 horizontal and not less than 1 vertical to 20 horizontal. Chutes more than 20 feet long and chutes not meeting the slope requirements may be used provided they discharge into a proper hopper.
- f. Runways: Provide runways or other means for wheeled equipment to convey concrete to placement points. Do not support runways on reinforcement, or wheel equipment over reinforcement.
- g. Pumps: Do not pump concrete without the Engineer's approval. Any change in concrete mix necessitated by pumping must be approved by the Engineer prior to placing concrete by this method.

17. Placing concrete:

- a. Place concrete in compliance with the practices and recommendations of ACI 304, and as specified herein. Do not place any concrete until the Engineer has reviewed the results of the design mix 28-day test breaks and approval is given to proceed.
- b. Concrete shall be deposited so that the aggregates are not segregated. Conveying concrete shall occur to prevent segregation of the aggregate. Conveying shall be by belt conveyor, tremmie, chutes or pumps. Vertical drops in excess 5 feet shall be conveyed using one of these techniques. Chutes shall not be used if the slopes are greater than 3:1.
- c. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
- d. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

- e. The concrete shall be deposited in continuous horizontal layers so that no concrete will be allowed to harden and cause the formation of seams or planes of weaknesses. Concrete placement shall occur at a rate to keep the placed concrete integral with the new concrete. Work shall be arranged in order that each part of the work shall be placed as a unit if this is possible. Where necessary to stop placing concrete, the work shall be brought up in level courses and against a vertical stop board.
 - f. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping, so that the concrete is thoroughly worked around reinforcement and embedded item and into the corners of forms. Consolidate each layer of concrete with previously placed layers in a manner that will eliminate all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Where internal vibrators are used, provide mechanical vibrators with a minimum frequency of 7000 revolutions per minute. Do not use vibrators to transport concrete. Insert and withdraw vibrators at points from 18 to 30 inches apart for 5 to 15 seconds duration. Keep a spare vibrator on the job site during all concrete operations.
 - g. Reinforcing steel position shall be held continuously during concrete placement.
 - h. The placing of concrete under water, where permitted, must be done by special accepted methods.
 - i. Formed elements: Use internal vibrators, not form vibrators. When a surface mortar is to be the basis of the finish, work coarse aggregate back from the forms with a suitable tool to bring a full surface of mortar against the form.
 - j. Supported elements: Use internal vibrators in elevated beams, girders and brackets and along construction joints. Consolidate elevated slabs with vibrating bridge screeds, roller pipe screens or other means approved by the Engineer. Tamp slabs to force aggregates away from surface and screen level to comply with ACI 347. After screeding, do not manipulate concrete prior to commencing finishing operations.
 - k. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.
18. Cold weather placement:
- a. Concrete placed during cold weather shall conform to ACI Code 306
 - b. Concrete to be placed when the air temperature has fallen to or expected to fall below 40°F shall be approved by the Engineer prior to placement. If concreting in freezing weather is permitted by the Engineer, the Contractor shall heat the water and aggregate in order that when deposited in the forms, the concrete will have a temperature of not less than 50°F, nor more than 80°F. Heated water and aggregate shall be combined in the mixer before cement is added. Cement shall

not be added to mixtures of water and aggregate when the temperature of the mixture is greater than 100°F.

- c. Concrete shall also be adequately protected in order to maintain proper temperatures. Ambient air temperatures shall be maintained for a minimum of three (3) days at 70°F or five (5) days at 50°F hours after it has been placed. Then, the temperatures shall be kept above 32°F for two (2) additional days. Temporary housings or coverings, such as tarpaulins or plastic film shall be used to maintain the temperatures. No chemicals, such as calcium chloride, salt or other foreign matter, shall be added to concrete containing reinforcement for the purpose of preventing freezing. The work shall be performed entirely at the Contractor's risk. Care shall be taken to avoid rapid drying of concrete due to overheating and to avoid thermal shock due to sudden heating and cooling.
- d. Frozen material containing snow and ice shall not be used. Concrete shall not be placed on frozen subgrade containing frozen materials. All forms, reinforcing steel, and adjacent concrete surfaces shall be free of frozen material before placing concrete.

19. Hot weather placement:

- a. Concrete placed during hot weather shall conform to ACI Code 305. The work shall be performed entirely at the Contractor's risk.
- b. Concrete to be placed when the air temperature has risen or expected to rise above 90°F shall be approved by the Engineer prior to placement. Acceptable methods to prevent overheating of the concrete prior to placement are as follows:
 - (1) Chilled water or chipped ice may be used to cool water below the temperature as long as the water equivalent is considered in the mixing process.
 - (2) Reinforcing steel shall be covered with wet burlap to lower the steel temperature below the ambient air temperature.
 - (3) Admixtures may be used to slow the concrete curing process.
 - (4) The subgrade and forms may be dampened. Care shall be taken to not oversaturate the subgrade, causing instability.
- c. After placement, the concrete shall be kept below 90°F for at least 24 hours. Acceptable methods for maintaining the temperature are as follows:
 - (1) Windbreaks that reduce the concrete temperatures may be used.
 - (2) Sunshades that reduce the concrete temperatures may be used.
 - (3) Fogging may be used to cool and moisten the surrounding air. Only fog nozzles designed for concrete fogging shall be used. Common garden hose or other types of nozzles shall not be used.

20. Bonding:

- a. Roughen surface of set concrete at all joints, except where bonding is obtained by use of a concrete bonding agent, and clean surfaces of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and to not leave laitance, loose particles of aggregate, or damaged concrete at the surface.
- b. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
 - (1) At joints between footings and walls and between walls and beams or slabs they support, and elsewhere unless otherwise specified herein, dampen but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete.
 - (2) At joints in exposed work; at vertical joints in walls; at joints in girders, beams, supported slabs and other structural members; and at joints designed to contain liquids; dampen, but do not saturate, the roughened and cleaned surface of set concrete and apply a liberal coating of neat cement grout.
 - (3) Use neat cement grout consisting of equal parts Portland cement and fine aggregate by weight and not more than 6 gallons of water per sack of cement. Apply with a stiff broom or brush to a minimum thickness of 1/16". Deposit fresh concrete before cement grout has attained its initial set.
 - (4) In lieu of neat cement grout, bonding grout may be commercial bonding agent. Apply to cleaned concrete surfaces in accordance with the printed instructions of the bonding material manufacturer.

21. Construction joints: Construction joints shall be located as shown on the plans and at other points as may be necessary during construction provided that the location and nature of additional joints shall be accepted by the Engineer. In general, joints shall be located at points of minimum shear, shall be perpendicular to the principal lines of stress, and shall have suitable keys having areas of approximately one-third (1/3) of the area of the joints. When placing against a construction joint, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance or other soft material, and shall be roughened. The surface shall then be thoroughly washed with clean water and covered with at least 2 inches of cement mortar, after which concreting may proceed. Mortar shall be placed in a manner that will not splatter forms and reinforcing steel.

22. Finish of concrete surfaces: All surfaces exposed to view shall be free from conspicuous lines, affects or other irregularities caused by defects in the forms. If for any reason this requirement is not met, or if there are any conspicuous honeycombs, the Engineer may require a correction of the defects by rubbing with carborundum bricks and water until a satisfactory finish is obtained. Immediately after removing the forms, all wires or other exposed metal shall be

cut back of the concrete surface and the depressions thus made and all honeycomb and other defects shall be painted with mortar and then rubbed smooth. If the Engineer deems any honey comb or other defect to require such treatment, the defective concrete shall be cut out to a depth sufficient to expose the reinforcement and to afford a key for the concrete replacing the cut out.

23. Curing concrete:

- a. Exposed surfaces of concrete shall be protected by accepted methods from premature drying for a period of at least seven (7) days. Curing compounds, when accepted by the Engineer, shall be applied according to the manufacturer's recommendations and shall not be used on any surface against which additional concrete is to be bonded, nor on surfaces which will be painted. In dry, hot weather, forms shall be removed as early as practicable and curing started immediately. The Engineer may require the frequent wetting of the concrete and the use of means to protect it from the direct rays of the sun.
 - (1) The Contractor shall protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
 - (2) The Contractor shall start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing and weather permitting, keep continuously moist for not less than 72 hours.
 - (3) The Contractor shall begin final curing procedures immediately following initial curing and before the concrete has dried; continue final curing for at least 7 days and in accordance with ACI 301 procedures; and avoid rapid drying at the end of the final curing period.
- b. Water curing: The Contractor shall moist cure the concrete using only water that is free of impurities which could etch or discolor exposed, natural concrete surface. The methods are as follows:
 - (1) Keeping the surface of the concrete continuously wet by covering with water.
 - (2) Continuous water-fog spray.
 - (3) Covering the concrete surface with the specified absorptive cover, thoroughly saturating the cover with water, and keeping the absorptive cover continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges, with a 4 inch lap over adjacent absorptive covers.
- c. Moisture Retaining Cover: The Contractor shall provide moisture retaining cover curing as follows: Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete, placed in the widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or

adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.

- d. Liquid membrane cover: The Contractor shall provide liquid membrane curing as follows:
 - (1) Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a 2-coat continuous operation by power spray equipment in accordance with the manufacturer's directions. Re-coat areas which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.
 - (2) Do not use membrane curing compounds on surfaces which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the Engineer.
- e. Curing formed surfaces: The Contractor shall cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed prior to specified curing period, continue curing by one of the methods specified in "Curing Unformed Surfaces".
- f. Curing unformed surfaces: The Contractor shall immediately after finishing operation is complete, commence curing unformed surfaces by one of the following methods:
 - (1) Continuously sprinkle or pond surface with water. Use this method for footings only.
 - (2) Cover surface with 2 inches of moist sand. Keep sand moist throughout the curing period. Use this method for footings only.
 - (3) Cover surface with moist fabric. Keep fabric moist and in direct contact with surface so that a film of water remains on the surface throughout the curing period. This method may be used on all concrete surfaces.
 - (4) Cover surface with curing paper. Lap sides and ends at least 3 inches and seal with tape. This method may be used on all concrete surfaces.
 - (5) Apply a uniform coat of liquid curing compound in accordance with manufacturer's recommendations. This method may be used on all concrete surfaces except those scheduled to receive bonded materials. Do not use this method in hot weather.
- g. Temperature of concrete during curing:

- (1) When the atmospheric temperature is 40° F and below, the Contractor shall maintain the concrete temperature between 50° F and 70° F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering, insulating, or housing, as required to maintain the specified temperature and moisture conditions, continuously for the concrete curing period. Do not use combustion the first 24 hours of curing without taking precautions to prevent exposure of the concrete to exhaust gases. Provide cold weather protection complying with the requirements of ACI 306.
 - (2) When the atmospheric temperature is 80° F, and above or during other climatic conditions which will cause too rapid drying of the concrete, the Contractor shall make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305. Maintain temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5 degrees F. in any one hour and 50 degrees F. in any 24 hour period.
- h. Protection from mechanical injury:
- (1) During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations. Do not allow any traffic (except for curing purposes) on the concrete surfaces until the concrete has attained 60% of its 28-day strength.
24. Removal of forms: Forms shall be removed in such manner as to ensure the complete safety of the structure. No forms shall be removed except with the express permission of the Engineer. In general, acceptance will be based on the following:
- a. Forms on ornamental work, railings, parapets and vertical surfaces which do not carry loads and which will be exposed in the finished work shall be removed within twenty-four (24) hours to forty-eight (48) hours after placing, as long as the temperature has been above 50° F the entire duration and the concrete hardness is such that the form removal will not damage the surface.
 - b. Form work supporting weight of concrete, such as beam soffits, joists, and slabs and other structural elements shall not be removed in less than fourteen (14) days and not until concrete has attained the design minimum twenty-eight (28) day compressive strength. Determine potential compressive strength of in-place concrete location or members under the least favorable conditions prevailing for any portion of the concrete.
 - c. Girder, beam and joint soffit forms shall remain in place with adequate shoring underneath, and no construction load shall be supported upon nor any shoring

removed from any part of the structure under construction until that portion of the structure has attained sufficient strength to support safely its weight and the loads placed thereon.

- d. Form facing material may be removed four (4) days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

25. Re-use of forms:

- a. The Contractor shall form lumber which is to be used a second time shall be free from bulge or warp and shall be thoroughly cleaned and repaired. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. The Contractor shall apply new form coating compound material to concrete contact surfaces as specified for new form work.
- b. When forms are extended for successive concrete placement, the Contractor shall thoroughly clean surfaces, remove fins and latence, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Owner's Representative.

26. Concrete surface repairs:

- a. Patching defective areas
 - (1) The Contractor shall repair and patch all defective areas with cement mortar immediately after removal of forms, but only when directed by the Engineer.
 - (2) The Contractor shall cut out honeycomb and rock pockets, down to concrete but, in no case, to a depth of less than 1 inch. In no case shall reinforcing metal be cut into. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water, and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the Engineer.
 - (3) For exposed-to-view surfaces, the Contractor shall blend white portland cement and standard portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.
 - (4) The Contractor shall fill holes extending through concrete by means of a plunger-type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to insure complete filling.
- b. Repair of formed surfaces

- (1) The Contractor shall repair of exposed-to-view formed concrete surfaces where possible, that contain defects which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolts; fins and other projections on the surface; and stain and other discoloration that cannot be removed by cleaning.
- (2) The Contractor shall repair concealed formed concrete surfaces, where possible, that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01 inch wide, cracks of any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts and spalls except minor breakage at the corner.

c. Repair of unformed surfaces:

- (1) The Contractor shall test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. The Contractor shall correct low and high areas as herein specified.
- (2) Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope, Correct high and low areas as herein specified.
- (3) Repair finished unformed surfaces that contain defects which adversely affect the durability of the concrete. Surface defects as such, include cracking, (cracks in excess of 0.01" wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width) spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
- (4) Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
- (5) Correct low areas in formed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete.
- (6) Repair defective areas, except random cracks and single holes not exceeding 1 inch diameter, but cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4" clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush

with a neat cement grout coating, or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same materials to provide compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

(7) Repair isolated random cracks and single holes not over 1 inch in diameter by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place drypack before the cement grout takes its initial set. Mix drypack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact drypack mixture in place and finish to match adjacent concrete. Keep patch areas continuously moist for not less than 72 hours.

(8) Repair methods not specified above may be used, subject to the acceptance of the Engineer.

C. Concrete encasement of pipelines:

1. General: Concrete encasement of pipelines may be used only by approval of the Engineer. Encasement shall be a minimum of 6 inches thick at the thinnest point. Encasement shall be plain concrete with no reinforcement, unless otherwise specified. All encasement will be placed as a monolithic placement.
2. Water lines: Water lines shall be encased where the cover over the line is not sufficient to spread surface loading and where trench widths are more than the maximum as shown on the Standard Details.
3. Sanitary sewer lines: Sanitary sewers may be encased when the depth of cut from the original ground elevation to the flow line of the pipe is 4 feet or less such as at stream crossings and where flotation may be a problem. Concrete encasement necessitated by trench widths more than the maximum as shown on the Standard Details shall be placed as directed by the Engineer. All concrete encasement required because of excessive trench width shall be placed at the expense of the Contractor.
4. Other utility lines: Where other utility lines require concrete encasement, the owner of the utility shall specify the method and thickness of encasement.

D. Concrete slab protection for pipelines: This item will be installed only as shown on the plans or at the direction of the Engineer. Where pipelines are within 24 inches of the surface or 24 inches of another pipeline, they will be covered with a 12 inches reinforced concrete slab. This slab will be placed in such a manner as to prevent accidental excavation into the pipeline. This slab shall be placed on a 2 inch thick rock bed over the pipeline. The excavation shall then be filled to ground level.

E. Concrete cradle for pipelines:

1. Concrete cradle of pipelines shall be a minimum of 6 inches thick at the thinnest point on the sides and bottom of the pipe. Cradle shall be plain concrete with no

reinforcement, unless otherwise specified. All cradle will be placed as a monolithic placement.

2. For sanitary sewers, a standard concrete cradle is required at any location where the depth of cut to the flow line of the pipe is 12 feet or more.
3. Concrete cradle necessitated by trench width more than the maximum as shown on the Standard Details shall be placed as directed by the Engineer. All concrete cradle required because of excessive trench width shall be placed at the expense of the Contractor.

F. Reinforced concrete piers for pipelines:

1. Piers shall be located and constructed as shown on the plans and Standard Details. Forms shall be made to conform to the shape of the pier and securely braced. Reinforcing steel shall be bent as detailed and securely tied in place.
2. Bearing area for the pipe shall be made to fit the outside diameter of the pipe and shall support the pipe at the proper grade. Steel strapping and bolts shall be installed and painted with one heavy coat of coal tar or asphalt paint after bolting in place.
3. Any honeycomb or other unevenness in the concrete shall be patched with cement mortar immediately after form removal.

END OF SECTION

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