

**SECTION 30 - CONCRETE STRUCTURES**  
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## **SECTION 30 CONCRETE STRUCTURES**

### **30-1 GENERAL**

Concrete structures shall conform to Section 51, "Concrete Structures", of the State Specifications, and these Specifications.

Work under this Section shall include constructing culverts, headwalls, retaining walls, slabs, foundations, and similar concrete structures. Concrete pavement, curbs, gutters, sidewalks, and drainage structures shall be as specified elsewhere in these Specifications.

### **30-2 FOOTINGS**

The elevations of the bottoms of footings shown on the Plans shall be considered as approximate only and the Agency may order, in writing, such changes in dimensions or elevations of footings as may be necessary for a satisfactory foundation. Additional structure excavation and structure backfill resulting from such changes will be measured and paid for as specified in Section 18-3, "Structure Excavation and Backfill", of these Specifications.

If the Contractor elects to fabricate materials or do other work prior to the final determination of footing elevations, the Contractor is responsible for additional costs incurred.

### **30-3 FORMS**

Forms shall be smooth and mortar tight, true to the required lines and grade, and of sufficient strength and supported in such a manner that no springing out of shape or sagging occurs between form supports during the placing of concrete. All dirt, chips, sawdust, nails and other foreign matter shall be completely removed from forms before any concrete is deposited. Forms shall be thoroughly coated with form oil, which shall be of high penetrating qualities leaving no film on the surface of the forms that can be absorbed by the concrete.

Forms for all surfaces that will be exposed to view shall be made of surfaced lumber or of other material that will provide a smooth and satisfactory surface. Lumber which is warped, badly checked, or contains loose knots or knot holes shall not be used on any surface form.

All sharp edges shall be chamfered with three-quarter inch by three-quarter inch (3/4" x 3/4") triangular fillets, unless the Plans specify that they not be used. Curved surfaces shall be formed in a manner that will give accurate and true surfaces. The Agency shall approve the construction methods of curved forms before such forms are placed.

Forms shall be constructed so that form marks conform to the general lines of the structure.

Only approved form clamps, ties, or bolts shall be used to fasten forms. Twisted wire ties will not be permitted.

The strength of the forms and the supporting structure for forms are the responsibility of the Contractor and permission by the Agency to place concrete in forms does not relieve the Contractor of this responsibility. If sagging or appreciable deflection or movement of the forms occurs as the concrete is being placed, the Agency may reject the work. Rejected work shall be removed and replaced at the expense of the Contractor.

### **30-4 REMOVAL OF FORMS**

In general, forms for columns and piers may be removed before those for beams and decks. Form removal should be based on the resulting effect on the concrete. That is, there must be no deflection, distortion or damage to the concrete. Supporting forms must not be removed from beams, floors and walls until they are able to carry their own weight and any approved live load. Unless otherwise specified in the Contract, no forms shall be removed until at least

twenty-four (24) hours after the concrete has been placed, and until the concrete has sufficient strength to prevent damage to the surface.

In no case should supporting forms be removed from horizontal members before concrete is eighty percent (80%) of design strength. When high-early strength concrete is used, removal time may be reduced at the discretion of the Agency. When retarding agents are used, removal time should be increased at the discretion of the Agency.

### **30-5 REINFORCEMENT**

Reinforcement in concrete structures shall be as shown on the Plans and conform to Section 31, "Reinforcement", of these Specifications.

### **30-6 MIXING AND TRANSPORTING**

Mixing and transporting of concrete shall be in accordance with Section 90 of the State Specifications. All concrete shall be mixed in mechanically operated mixers except when permitted by the Contract. Concrete being transported must maintain consistency and workability; no additional mixing water shall be incorporated unless authorized by the Agency.

The use of admixtures in concrete for structures will be subject to the written approval of the Agency, or as otherwise specified in the Special Provisions.

Unless otherwise shown or specified in the Contract, concrete in structures shall be Class 1 as specified in Section 90-1.01 of the State Specifications.

### **30-7 PLACING CONCRETE**

#### **30-7.01 General**

No concrete shall be placed in forms until the forms have been approved by the Agency.

Concrete shall not be placed on frozen or ice-coated ground or subgrade, or on ice-coated forms, reinforcing steel, structural steel, conduits, precast members, or construction joints.

Under rainy conditions, placing of concrete shall be stopped before the quantity of surface water is sufficient to damage surface mortar or cause a flow or wash of the concrete surface, unless the Contractor provides adequate protection against damage, as determined by the Agency.

All concrete shall be fresh and shall be placed before it has taken an initial set. Retempering with additional water to make concrete more workable after it has partially hardened will not be permitted. The temperature of the concrete at the time of placement shall not fall below fifty-five degrees (55°) or exceed ninety degrees (90°) F, per ACI Manual of Concrete Practice Table 3.1.

#### **30-7.02 Placement**

When the Contract shows or specifies a concrete placement sequence or schedule, such a sequence or schedule shall not be varied without written approval of the Agency.

Fresh concrete shall be placed in horizontal layers no deeper than can be satisfactorily consolidated with the vibrators. The concrete shall be placed at or near its final position; the use of vibrators for extensive shifting of fresh concrete will not be permitted. Fresh concrete shall not be permitted to fall from a height greater than six feet (6'). Tremies or "elephant trunks" shall be used if the concrete is to be placed in a deep or hard to reach area.

After being deposited, the fresh concrete shall be consolidated by mechanical vibration until voids are filled and free mortar appears on the surface.

The use of additional water in mixing the concrete to promote free flow will not be permitted.

**30-7.03 Vibrating**

The location, manner, and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate. Vibrators shall not be attached to or held against the forms or the reinforcing steel. The use of external form vibrators will only be permitted with written approval of the Agency when the concrete is inaccessible for adequate internal consolidation, and the forms are constructed sufficiently rigid to resist displacement or damage from external vibration.

Concrete in structures shall be tamped and consolidated by means of high frequency internal vibrators of a size, type, and number as approved by the Agency. The number of vibrators shall be sufficient to consolidate the incoming concrete within fifteen (15) minutes after it is deposited in the forms. No less than two (2) serviceable vibrators shall be available at all times. Surfaces shall be smooth and free from voids caused by rock pockets. Where necessary, vibration shall be supplemented by hand spading to secure these results.

**30-8 BONDING**

Non-epoxy bonding compounds shall be used for dry areas and epoxy resin bonding compounds shall be used for areas exposed to moisture. Bonding compounds shall be applied in accordance with the manufacturer's instructions.

Epoxy resins may be used for grouting dowels in concrete, crack injection, adhesive for bonding fresh and hardened concrete, as a binder for epoxy mortar in making concrete repairs, and under water. Some epoxies are not suitable for temperature extremes such as freeze-thaw environments; placing shall be done within manufacturer's allowable parameters. Epoxies may be fast-setting when approved by the Agency. The epoxy binder and adhesive shall be two-component mixture conforming to Section 95-2.01, "Binder (Adhesive), Epoxy Resin Base", of the State Specifications, and shall be mixed at the work site. Safety, proportioning, mixing, and temperature are critical and shall be done according to manufacturer's instructions. Aggregate shall conform to Section 90-2.02, "Aggregates", of the State Specifications. When using epoxy as a binder to make mortar, the two components shall be thoroughly mixed to a uniform gray color before the aggregate is added. Unless otherwise specified, the mix proportions shall be one (1) part epoxy binder to four (4) parts aggregate by volume. When fine aggregate (sand) is used, the mix shall be one (1) part epoxy binder to six (6) parts aggregate, by volume. The aggregate shall have a moisture content of not more than one-half of one percent (0.50%) when mixed with binder. The aggregate size and proportions shall be determined by the Contractor, subject to the approval of the Agency.

Appropriate uses of epoxy resin shall conform to Section 95, "Epoxy", of the State Specifications.

**30-9 CONCRETE PLACED UNDER WATER**

Unless specifically shown or specified in the Contract, no concrete may be placed underwater without written direction from the Agency.

When underwater placement of concrete is directed, the placement shall be by approved tremie or bottom dump bucket. The consistency of the concrete shall be appropriate for underwater placement and must be approved in writing by the Agency. Underwater placement shall be continuous until completed. Placing concrete in running water will not be permitted.

**30-10 EXPANSION JOINTS**

When premolded joint filler is shown or specified in the Contract, the filler shall be anchored in the correct position before concrete is placed. The edges of the concrete at the joint shall be finished with a one-quarter inch (1/4") radius edging tool. Unless otherwise specified in the

Contract, expansion joint material shall be as specified in Section 50-4, "Premolded Expansion Joint Filler", of these Specifications, except that partial depth expansion joint filler material with a minimum penetration of two inches (2") will be permitted in minor concrete structures, slope paving, sidewalk, curb, and gutter applications as specified in Section 90-10, "Minor Concrete", of the State Specifications.

### **30-11 CONSTRUCTION JOINTS**

Construction joints are required when sequencing concrete placement of large areas.

Construction joints shall be made only where shown or specified in the Contract or authorized or directed by the Agency. When it is necessary to make a joint because of an emergency, as determined by the Agency, reinforcing steel shall be placed through the joint as directed by the Agency. Furnishing and placing such reinforcing steel shall be at the Contractor's expense and no additional compensation will be paid.

After the concrete in a poured segment has hardened, the entire surface of the joint shall be thoroughly cleaned of surface laitance, and aggregate shall be exposed by abrasive blast cleaning. Wire brushing, air, or water blasting may be used while the concrete is fresh, provided results equal to abrasive blast cleaning are obtained.

Construction joints shall be keyed. Keyways shall be formed by beveled strips or boards placed at right angles to the direction of shear or as directed by the Agency. Except where otherwise shown or specified in the Contract, keyways shall be at least one and one-half inches (1-1/2") deep over at least twenty-five percent (25%) of the area of the section.

When new concrete is to be joined to existing concrete, holes shall be drilled in the existing concrete and bar reinforcing steel dowels shall be grouted in, as specified in Section 51-1.13, "Bonding", of the State Specifications.

### **30-12 WATERSTOPS**

Waterstops, when shown or specified in the Contract, shall conform to the requirements of Section 51-1.14, "Waterstops", of the State Specifications.

### **30-13 CURING**

Curing of concrete is essential for development of specified strength and durability. When not curing by forms-in-place, then exposed surfaces shall be cured by one or more of the following methods: burlap or rugs kept continuously wet, waterproof membranes such as paper or plastic, or spraying liquid-membrane curing compound applied as soon as free water on the surface has disappeared but before surface drying begins. Unless otherwise shown or specified in the Contract, curing compounds shall conform to the requirements in Section 50-6, "Curing Compounds for Concrete", of these Specifications.

Curing practices for concrete placed in extreme weather conditions must prevent too-rapid hydration or cold-weather freeze-thaw damage as specified in ACI Manual of Concrete Practice (most recent) or Section 90-7 of the State Specifications.

### **30-14 PROTECTING CONCRETE**

In addition to the requirements of Section 5, "Control of Work and Materials", of these Specifications, the Contractor shall protect concrete as provided in this Section 30.

All concrete that has been frozen or damaged by other causes, as determined by the Agency, shall be removed and replaced by the Contractor at the Contractor's expense.

All concrete in structures shall be maintained at a temperature of not less than forty-five degrees (45°) F for seventy-two (72) hours after placement, and at not less than forty degrees

(40°) F for an additional four (4) days. When required by the Agency, the Contractor shall submit a written outline of the proposed methods for protecting the concrete.

### **30-15 SURFACE FINISH**

#### **30-15.01 General**

All exposed surfaces of structures shall have a smooth form finish as specified in the ACI Manual of Concrete Practice 301.5.3.3, "Finishing Formed Surfaces", unless otherwise shown or specified in the Contract. All other surfaces shall have an ordinary surface finish unless otherwise shown or specified in the Contract.

Immediately after forms have been removed, all form bolts shall be cut off one inch (1") below the finished surface of the structure and the holes remaining shall be filled with cement mortar using one (1) part cement to two (2) parts sand. Add white cement as needed to match surrounding concrete on all exposed surfaces.

Any defects in the concrete surface caused by poor material in the forms, poor form construction, or by voids or pockets in the concrete, shall be repaired and finished to make the surface finish uniform. The Agency may direct the Contractor to correct such defects at the Contractor's expense.

#### **30-15.02 Smooth Form Finish (Sacking)**

A smooth form surface for exposed surfaces or preparation for coating shall consist of finishing the surfaces of the structure as necessary to produce smooth, even surfaces of uniform texture and appearance, free of unsightly bulges, depressions and other imperfections. The degree of care in building forms and character of materials used in form work will be a contributing factor in the amount of additional finishing required to produce smooth, even surfaces of uniform texture and appearance, free of unsightly bulges, depressions and other imperfections, and the Agency shall be the sole judge in this respect. The use of power carborundum stones or disks may be required to remove bulges and other imperfections. The grout-cleaned finish (sacking) requires a sound, clean, dry substrate. Grind surfaces, including seams, bumps, and imperfections smooth and flat. Remove form release agent, laitance, and cure, if present. If coating is required, provide a profile for coating adherence by whip-blasting or acid-etching. Wet a small area of concrete to be sacked and rub a slurry of gray concrete, white concrete (to match existing color), and fine sand into the surface with a sponge float, filling all holes. Non-epoxy acrylic bonding compound may be used in the slurry or in the water. Scrape off excess slurry and rub area lightly with a burlap sack until uniform in appearance. If approved by the Agency, a cementitious mortar may be troweled on the concrete surface after achieving a smooth and flat surface by grinding, including seams, bumps, and imperfections.

#### **30-15.03 Ordinary Surface Finish**

The ordinary surface finish required on non-exposed concrete structures shall be minimized by careful forming, use of quality materials, and proper concrete placement procedures. Ordinary surface finish shall consist of removing snap ties and bolts to a minimum depth of one inch (1") and filling the holes. Holes or depressions three-eighths inch (3/8") or larger shall be filled, all rock pockets shall be repaired, and all fins shall be removed.

#### **30-15.04 Tolerance on Concrete Paving**

All concrete structures having a roadway deck shall have a smooth riding surface. The finished surface shall be tested with a twelve-foot (12') straight edge. The surface shall not vary more than 0.01 foot from a plane defined by the lower edge of the straight edge. All areas higher than 0.01 foot above the test plane shall be removed by abrasive means. All areas lower than 0.01 foot below the test plane shall be cut out to a depth of one inch (1") below the test plane and patched with epoxy concrete.

**30-15.05 Concrete Repair****30-15.05.A General**

Evaluate the unsuitable concrete area to determine whether the concrete repair should be made with concrete, mortar (dry pack), shotcrete, or topped with an overlay.

**30-15.05.B Replacement with Concrete**

When there are extensive honeycombs or large voids in new construction, or extensive deterioration of existing concrete, the affected area shall be removed to sound concrete and the area cleaned of deleterious material. Forming may be required. Concrete for the repair shall be similar to the original in cement-water ratio and aggregate size.

**30-15.05.C Mortar (Dry Pack)**

This method is suitable for snap-tie holes, spalls, and cavities (rock pockets) with a relatively high ratio of depth to width. Unsuitable concrete must be chipped by hand or mechanical means to sound and clean concrete. Flush the patch area with water and allow to dry. Coat surface with epoxy compound or acrylic bonding compound and allow to dry until tacky to the touch. Mix mortar composed of portland cement, sand, and water. White cement shall be added when matching the color of the surrounding concrete is required. Proportion of cement to sand, by volume, shall be no more than 1:2. Add only enough water to permit placing and packing. The mortar shall be rammed into place in thin layers and leveled to the plane of the surrounding concrete. Cure with liquid-membrane cure, wet burlap, or water. Fast-setting, cementitious, pre-mixed packing materials may be used when approved by the Agency and shall be applied per manufacturer's instructions.

**30-15.05.D Shotcrete**

Shotcrete is suitable for repairs to overhead or vertical surfaces and shall be placed according to procedures in ACI Manual of Concrete Practice, 506R.

**30-15.05.E Topping**

Topping may be placed with or without surface hardener on a pre-existing base slab. Prior to placing, the entire area to be topped shall be cleaned and free of all loose and unsound materials by abrasive blasting or machine scarifying, and clean aggregate exposed. The cleaned base shall be kept wet for a period of 24 hours prior to the application of topping. Excess water shall be removed and a neat cement bonding grout shall be applied. It shall be of equal parts cement and sand and enough water to make a creamy mixture. The cement bonding grout shall not be allowed to dry or set before topping placement. Bonding agents other than cement grout may be used with prior Agency approval. The topping shall then be placed to grade, compacted, and floated. The Contractor shall check for trueness of surface with a 12-foot straightedge. Surface hardener, when used, shall be applied according to manufacturer's instructions. Trowel or broom finish as specified in Contract.

**30-16 MEASUREMENT AND PAYMENT**

Except as otherwise provided, pay quantities of concrete in structures will be measured by the cubic yard in accordance with the dimensions shown or specified in the Contract, or as ordered in writing by the Agency. No deduction will be made for volume of reinforcing steel.

The price paid per cubic yard for concrete in structures includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in constructing concrete structures, complete in place, including furnishing and building all necessary forms and falsework, furnishing and placing all concrete, reinforcing steel, expansion joint material and waterstops, curing the concrete, providing weep holes in walls, and finishing all concrete surfaces, as shown or specified in the Contract, specified in these Specifications, and directed by the Agency.

