

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

30-1 **GENERAL**

Concrete structures must conform to the State Specifications, and these Specifications. Work under this Section includes constructing culverts, headwalls, retaining walls, slabs, foundations, and similar concrete structures. Concrete pavement, curbs, gutters, sidewalks, and drainage structures must be as specified elsewhere in these Specifications.

30-2 **FOOTINGS**

The elevations of the bottoms of footings shown on the Plans is approximate only and the Agency may order, in writing, changes in dimensions or elevations of footings as 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 must 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 must be completely removed from forms before any concrete is deposited. Forms must be thoroughly coated with form oil, which must 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 must be made of surfaced lumber or of other material that will provide a smooth and satisfactory surface. Lumber that is warped, badly checked, or contains loose knots or knot holes cannot be used on any surface form.

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

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

Only approved form clamps, ties, or bolts can be used to fasten forms. Twisted wire ties are not 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 must 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 can be removed until at least 24 hours after the concrete has been placed, and until the concrete has sufficient strength to prevent damage to the surface.

Supporting forms must not be removed from horizontal members before concrete is 80 percent 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 must 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 must be in accordance with the State Specifications. All concrete must be mixed in mechanically operated mixers except when permitted by the Contract. Concrete being transported must maintain consistency and workability; no additional mixing water must 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.

30-7 PLACING CONCRETE

30-7.01 General

Do not place concrete in forms until the forms have been approved by the Agency.

Concrete must 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 must 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 must be fresh and must be placed before it has taken an initial set. Retempering with additional water to make concrete more workable after it has partially hardened is not permitted. The temperature of the concrete at the time of placement must be between 55 and 90 degrees F, per ACI Manual of Concrete Practice Table 3.1.

Existing concrete surfaces to be connected to new concrete must be thoroughly cleaned as directed by the Inspector, and the surface must be roughened to approximately 1/4-inch depth. Irregular voids or surface stones may be left in place if sound, free of laitance, and firmly embedded.

30-7.02 Placement

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

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

After being deposited, the fresh concrete must 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 is not permitted.

30-7.03 Vibrating

The location, manner, and duration of the application of the vibrators must achieve maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate. Vibrators must not be attached to or held against the forms or the reinforcing steel.

With written approval of the Agency, the use of external form vibrators is permitted 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 must be tamped and consolidated by means of high frequency internal vibrators of a size, type, and number approved by the Agency. The number of vibrators must be sufficient to consolidate the incoming concrete within 15 minutes after it is deposited in the forms. No less than 2 serviceable vibrators must be available at all times. Surfaces must be smooth and free from voids caused by rock pockets. Vibration must be supplemented by hand spading to secure these results.

30-8 BONDING

Non-epoxy bonding compounds must be used for dry areas and epoxy resin bonding compounds must be used for areas exposed to moisture. Bonding compounds must 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 must be done within manufacturer's allowable parameters. Epoxies may be fast-setting when approved by the Agency. The epoxy binder and adhesive must be a two- component mixture conforming to the State Specifications and must be mixed at the work site. Safety, proportioning, mixing, and temperature are critical and must be done according to manufacturer's instructions. Aggregate must conform to the State Specifications. When using epoxy as a binder to make mortar, the two components must be thoroughly mixed to a uniform gray color before the aggregate is added. Unless otherwise specified, the mix proportions must be 1 part epoxy binder to 4 parts aggregate by volume. When fine aggregate (sand) is used, the mix must be 1 part epoxy binder to 6 parts aggregate, by volume. The aggregate must have a moisture content of not more than 0.50 percent when mixed with binder. The aggregate size and proportions must be determined by the Contractor, subject to the approval of the Agency.

Appropriate uses of epoxy resin must conform to the State Specifications.

30-9 CONCRETE PLACED UNDER WATER

Unless specifically shown or specified in the Contract, concrete may not be placed underwater without written direction from the Agency.

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

30-10 EXPANSION JOINTS

When premolded joint filler is shown or specified in the Contract, the filler must be anchored in the correct position before concrete is placed. The edges of the concrete at the joint must be finished with a 1/4 inch radius edging tool. Unless otherwise specified in the Contract, expansion joint material must 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 2 inches is permitted in minor concrete structures, slope paving, sidewalk, curb, and gutter applications as specified in the State Specifications.

30-11 CONSTRUCTION JOINTS

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

Construction joints must 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 must be placed through the joint as directed by the Agency. Furnishing and placing such reinforcing steel is 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 must be thoroughly cleaned of surface laitance, and aggregate must 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 must be keyed. Keyways must 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 must be at least 1-1/2 inches deep over at least 25 percent of the area of the section.

When new concrete is to be joined to existing concrete, holes must be drilled in the existing concrete and bar reinforcing steel dowels must be grouted in, as specified in the State Specifications.

30-12 WATERSTOPS

Waterstops, when shown or specified in the Contract, must conform to the requirements 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 must 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 must 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 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 must protect concrete as provided in this Section.

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

Concrete in structures must be maintained at a temperature of at least 45 degrees F for 72 hours after placement, and at least 40 degrees F for an additional 4 Calendar Days. When required by the Agency, the Contractor must 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 must 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 must have an ordinary surface finish unless otherwise shown or specified in the Contract.

Immediately after forms have been removed, all form bolts must be cut off 1 inch below the finished surface of the structure and the holes remaining must be filled with cement mortar using 1 part cement to 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, must 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 must consist of finishing the surfaces of the structure to produce smooth, even surfaces of uniform texture and appearance, free of 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 will 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 must be minimized by careful forming, use of quality materials, and proper concrete placement procedures. Ordinary surface finish consists of removing snap ties and bolts to a minimum depth of 1 inch and filling the holes. Holes or depressions 3/8 inch or larger must be filled, all rock pockets must be repaired, and all fins must be removed.

30-15.04 Tolerance on Concrete Paving

All concrete structures having a roadway deck must have a smooth riding surface. The finished surface must be tested with a 12-foot straight edge. The surface must 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 must be removed by abrasive means. All areas lower than

0.01 foot below the test plane must be cut out to a depth of 1 inch 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 must be removed to sound concrete (a minimum of 1 inch) and the area cleaned of deleterious material. All sides must be square; forming may be required. Concrete for the repair must 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 must be added when matching the color of the surrounding concrete is required. Proportion of cement to sand, by volume, must be no more than 1:2. Add only enough water to permit placing and packing. The mortar must 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 must be applied per manufacturer's instructions.

30-15.05.D Shotcrete

Shotcrete is suitable for repairs to overhead or vertical surfaces and must 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 must be cleaned and free of all loose and unsound materials by abrasive blasting or machine scarifying, and clean aggregate exposed. The cleaned base must be kept wet for a period of 24 hours prior to the application of topping. Excess water must be removed and a neat cement bonding grout must be applied. It must be of equal parts cement and sand and enough water to make a creamy mixture. The cement bonding grout must 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 must then be placed to grade, compacted, and floated. The Contractor must check for trueness of surface with a 12-foot straightedge. Surface hardener, when used, must 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.