

SECTION 0302

CONCRETE STRUCTURES

0302.0100 GENERAL

0302.0101 Description of Work. The work under this section shall consist of furnishing all materials and constructing concrete structures or parts of concrete structures to the forms, shapes and dimensions shown on the project plans and to the lines and grades established by the Engineer and in accordance with the requirements of these specifications. When the structures or parts of structures are precast, the work shall also include transporting and placing the units.

0302.0200 PRODUCTS

0302.0201 Materials.

(A) **Portland Cement Concrete.** Portland cement concrete shall conform to the requirements of Section 0301 for Class A or Class B as shown on the project plans.

Where a compressive strength is shown on the project plans, but a class of concrete is not indicated, it shall be intended to mean Class A concrete having the minimum 28-day compressive strength shown.

(B) **Concrete Curing Compound.** Curing compound shall be a liquid membrane-forming compound conforming to the requirements found in Section 0302.

(C) **Expansion Joint Filler.** Materials furnished for expansion joint filler and joint seal shall conform to the requirements of Section 1011 of the Pima County/City of Tucson Standard Specifications for Public Improvements.

(D) **Reinforcing Steel.** Reinforcing steel shall conform to the requirements of Section 0303.

0302.0300 EXECUTION

0302.0301 Foundations. Foundations for structures shall be placed on suitable earth or rock bearing, on a concrete foundation seal, or on piling, as shown on the project plans. Excavation and backfill shall be in accordance with the requirements of Subsections 203 through 205. Except where tremie concrete is specified, no concrete shall be placed under water or against water-bearing strata.

0302.0302 Forms.

(A) **Design and Drawings.** The contractor shall be responsible for designing and constructing safe and adequate forms which provide the necessary rigidity, support the loads imposed, and produce in the finished structure the lines, grades, and dimensions shown on the project plans and established by the Engineer.

Forms shall be any system of structural elements which provide horizontal support or restraint to the lateral pressure of concrete.

(B) Construction:

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(1) **General.** Forms shall be of wood, metal or other suitable material conforming to the requirements specified herein.

The forms shall be mortar tight and shall be designed, constructed, braced and maintained so that the finished concrete will be true to line and elevation and will conform to the required dimensions and contours. They shall be designed to withstand the pressure of concrete, with consideration given to the rate of concrete placement, temperature of the concrete, use of set-retarding admixtures or pozzolanic materials in the concrete, the effects of vibration as the concrete is being placed and all loads incidental to the construction operations, without distortion or displacement. Forms shall be maintained to eliminate the formation of joints due to shrinkage of the lumber.

Stay-in-place forming shall not be used unless specified on the plans or approved by the Engineer. Expanded metal meshes may be used to form construction joints provided: a three inch cover is maintained.

Forms shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, watertightness and smoothness of surface. Forms or form lumber unsatisfactory in any respect shall not be used.

Forms shall be constructed so that portions may be removed without disturbing forms that are to remain. All form joints shall be taped or caulked in an acceptable manner. Forms for this work shall be equivalent to first class pattern work.

Forms shall be filleted 3/4-inch at all exposed, sharp corners of the concrete.

All forms shall be treated with an approved form release agent before concrete is placed. Any material which will adhere to or discolor the concrete shall not be used.

Forms shall be cleaned of all dirt, sawdust, water and other foreign material prior to placing concrete in the forms.

Where the bottom of the form is inaccessible, provisions shall be made for cleaning out extraneous material immediately before placing the concrete.

(2) **Wood Forms.** All lumber used for forms shall be free from defects affecting the accuracy of shape, strength, rigidity, watertightness and smoothness of the surface. All lumber for forms above a stream bed shall be plywood. All form lumber shall be securely fastened to the studding so that cupping cannot occur. Chamfer strips shall be of selected material dressed to true line and uniform dimensions. The interior surfaces of all forms in contact with concrete surfaces which will be exposed in the finished work shall be smooth and even. No uneven or offset joints or single boards projecting so that their impressions are left in the concrete will be allowed. Forms, as far as practicable, shall be so constructed that the form marks will conform to the general lines of the structure. In general, grain of the lumber and direction of side joints shall be horizontal on wide faces and walls and vertical on narrow faces. If varying widths of panels are used, the wider panels shall be placed on the bottom and the

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narrower ones near the top. Panel and joints shall be staggered not less than three feet. Spreaders made of wood shall not be left in the concrete.

(3) Metal and Fiberglass Forms. The same provisions as specified under wood forms shall apply to metal and fiberglass forms and in addition thereto, the following shall apply:

All bolts and rivet heads shall be countersunk. Clamps, rods, pins or other connecting devices shall be designed to hold the forms rigidly together and allow removal without injury to the concrete. Forms which do not present a smooth surface or are not properly aligned shall not be used.

Care shall be exercised to keep the forms free of rust, grease or other foreign matter which will tend to discolor the concrete.

(C) Removal of Forms. No forms shall be removed prior to the curing time specified in Section 0301.

In the determination of the time for removal of forms, consideration shall be given to the location and character of the structure, the weather, and other conditions influencing the setting of the concrete and the materials used in the concrete.

The Engineer may reduce these periods if high-early strength concrete is used or if the compressive strength of cylinders, cured under conditions similar to those in the field, indicate that the anticipated 85 percent of the 28-day compressive strength has been achieved. The Engineer may extend the above periods for reasons of cold weather or other conditions which may retard the setting of the concrete.

Side forms for footings, curbs, or other members where the forms do not resist dead load bending may be removed after the concrete has set and the contractor shall cure and protect the concrete thus exposed in accordance with the requirements of Section 0302. The contractor shall assume all risks and responsibility resulting from such removals.

Placement of backfill material shall be in accordance with Subsection 0205-0304. Where backfill is to be placed against both sides of a structural element, the backfill elevations on one side of the element shall not exceed the backfill elevations on the opposite side of the element by more than five feet.

Care shall be taken in removing forms so as not to deface or injure the structure. Methods of removal likely to damage or cause over-stressing of the concrete shall not be used.

0302.0303 Placing Concrete.

(A) General. No concrete shall be placed in a foundation until the extent of the excavation and the character of the bearing material have been approved and no concrete shall be placed in any structure until the placement of reinforcing steel and the adequacy of the forms and falsework have been approved by the Engineer.

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Formwork, reinforcing steel, waterstop, and all materials required for the complete and satisfactory installation of concrete structures shall be complete, in place, 24 hours prior to any scheduled concrete pour to permit adequate time for inspection work. Concrete shall not be placed until all necessary corrections have been made by the contractor and all work required for the proposed pour has been completed.

Reinforcing steel shall be handled and placed in accordance with the requirements of Section 0303.

When concrete is placed on or against soil, the soil shall have been compacted, at its optimum moisture content, to a minimum of 95 percent of its maximum density. Prior to placement of concrete the soil shall be mist sprayed with water so as to moisten all dry, absorbent surfaces with which the concrete will be in contact. Care shall be taken to avoid ponding water within the area of concrete placement.

Concrete shall be placed and consolidated by methods that will not cause harmful segregation or displacement of reinforcement, and will result in dense, homogeneous concrete free of honeycomb or voids.

Concrete shall be placed in horizontal layers not over 18-inches in depth unless otherwise approved by the Engineer. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and consolidated before the preceding layer has taken its initial set to prevent damage to the green concrete and avoid cold joints.

Concrete shall be placed as nearly as possible in its final position and the use of vibrators for shifting the mass of fresh concrete will not be permitted. Dropping the concrete more than five feet without the use of approved pipes or tubes will not be allowed.

Care shall be taken to fill all areas within the forms, to work the coarser aggregates back from the face of the concrete, and to force the concrete under and around the reinforcement without displacing the reinforcement or other embedded items.

Conveying equipment shall be capable of providing a supply of concrete to the point of placement without segregation of ingredients or interruptions sufficient to permit loss of plasticity between placement of successive layers.

Concrete placed in slabs and floors shall be struck off by means of a screed. The screed may be self-propelled screed equipment or by manual methods.

When manual methods are permitted, concrete shall be deposited, spread and struck off to such an elevation that, when properly consolidated, the surface will conform to the required lines and grades. The strike board shall be moved forward with a combined longitudinal and transverse motions so that neither end is raised from the side forms. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure.

The rate of concrete placement and consolidation shall be such that the formation of cold joints within monolithic sections of any structure will not occur. Any portion of any structure displaying apparent

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cold joints will be rejected, unless the contractor, at his expense, can submit evidence that will indicate that either a cold joint does not exist or that a cold joint is not detrimental to the structure. The Engineer shall be the sole judge in determining the existence of a cold joint and whether its existence is detrimental to the structure. The rate of concrete placement for major structures shall not be less than 35 cubic yards per hour unless otherwise approved in writing by the Engineer.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

(B) Pumping Concrete. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be of suitable type and shall have adequate capacity for the work. The concrete shall not flow either over or through any piping, fittings or equipment which is fabricated of aluminum or aluminum alloys. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. Excessive segregation due to high velocity discharge of the concrete will not be permitted. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or segregation of the ingredients. Standby equipment shall be readily available to replace initial pumping equipment should breakdown occur.

(C) Vibrating Concrete. All concrete in structures shall be consolidated by means of approved vibrators together with any other equipment necessary to perform the work as specified herein. The minimum frequency of the internal vibrators shall be as specified in Table 302-1 and produce a vibration of sufficient intensity to consolidate the concrete into place without separation of the ingredients.

TABLE 302-1

VIBRATOR ELEMENT FREQUENCIES

	Frequency, Minimum Cycles/Minute
Surface, Pan or Screed	3500
Immersion Tube, Paving Machine Attachment	5000
Immersion Spud, Hand Operated	8000
Immersion Spud, Gang Mounted	8000

Vibration shall be applied in the area of the freshly deposited concrete. Vibrators shall penetrate to the bottom of the concrete layer and at least six inches into the preceding layer. The vibration shall be of sufficient duration and intensity to consolidate the concrete thoroughly within 15 minutes after it has been deposited in the forms. The vibrating element shall be inserted in the concrete mass in as nearly a vertical position as practicable. It shall be withdrawn completely from the concrete before being advanced to the next point of application. Internal vibrators shall not be applied directly to the forms or to the reinforcing steel.

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Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

The vibrator shall not be used to push or distribute the concrete laterally.

To secure even and dense surfaces, free from aggregate pockets or honeycomb vibration shall be supplemented by working or spading by hand in the corners and angles of forms and along form surfaces while the concrete is plastic.

Revibration of concrete may be required at any time as directed by the Engineer.

The contractor shall provide sufficient equipment to insure uninterrupted and continuous vibration of the concrete.

(D) Placing Concrete in Water (Tremie Concrete). Tremie concrete shall be deposited in water only if either specified on the project plans or when directed and then only under the Engineer's supervision. When depositing in water is allowed, the concrete shall be carefully placed in a compact mass in the space in which it is to remain by means of a tremie, bottom dump bucket or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being deposited. No concrete shall be placed in running water and forms which are not reasonably watertight shall not be used for holding concrete deposited under water.

A head of concrete shall remain above the discharge end of the tremie tube at all times.

0302.0304 Finishing Concrete.

(A) General. The appropriate finish, as specified herein, shall be applied to each surface of all concrete structures.

All formed surfaces will require finishing. Formed surfaces shall be finished immediately after the removal of forms in accordance with the requirements specified herein. If rock pockets or honeycomb are of such an extent and character as to affect the strength of the structure and to endanger the steel reinforcement, the Engineer may declare the concrete defective and require the removal and replacement of that portion of the structure affected at the expense of the contractor.

Formed surfaces normally in view of vehicular or pedestrian traffic, or not covered by fill material shall present a pleasing appearance of uniform color and texture commonly achieved by the use of clean, smooth plywood forms joined tightly or taped at the joints, preformed metal forms, paper tubing forms, or specially coated forms. If a pleasing appearance has not been achieved, either in the formed surface or at the joints, the Engineer will order that the surface be finished in accordance with the requirements for a Class II Finish.

(B) Class I Finish. All bolts, wires, snap-ties, and rods shall be clipped and recessed one inch below the surface of the concrete. All holes, honeycomb, rock pockets and other surface imperfections shall be cleaned to sound concrete, thoroughly moistened and carefully patched with mortar.

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Mortar shall be composed of one part cement, two parts of fine sand, water and an adhesive of a type approved by the Engineer. A portion of the required cement shall be white as required to match the color of the surrounding concrete. Small voids due to entrapped air and water in precast members need not be patched.

(C) **Class II Finish.** The surface shall be patched and pointed as specified herein for Class I finish. When the mortar used in patching and pointing has set sufficiently, the surface shall be rubbed with cork, wood, or rubber floats, polystyrene, or a mechanical carborundum stone. During the rubbing process a thin mortar, matching the color of surrounding concrete, may be used to facilitate producing a satisfactory lather. The mortar used to produce a lather shall not be used in quantities sufficient to cause a plaster coating to be left on the finished surface. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform texture and color.

0302.0305 Curing Concrete. The contractor shall be solely responsible for insuring quality concrete operations at all times in order to prevent the formation of cracks. The appearance of cracks, other than normal, infrequent, sporadic, hairline, dry-shrinkage cracks will be cause for rejection of the concrete.

Curing cast-in-place and curing precast concrete members shall be in accordance with the requirements of Subsection 0301.0303(D & E).

0302.0306 Backfilling. Structure backfill shall be placed in accordance with the requirements of Subsection 0205.0304(C)(2).

0302.0307 Compressive Strength and Acceptance. Sampling and testing for compressive strength and acceptance for compressive strength will be in accordance with the requirements found in Subsection 0301.0303(E-3).

0302.0308 Repair of Defective Concrete. All defective work shall be removed and replaced or repaired. Any work which has not been constructed in accordance with the Plans and Specifications shall be considered defective.

Correction of defective work shall be specified herein. No defective work shall be patched, repaired, or covered without inspection by the Engineer. Repair shall have strength equal or greater than the specified concrete for the area. The Contractor shall provide a mix design for the grout which is proposed for use to the Engineer for review and acceptance.

All imperfections in the work shall be chipped out and keyed ready for repair. The dry pack method shall be used for holes having a depth nearly equal to or greater than the least surface dimension of the hole, for cone-bolt, and narrow slots cut for repair. Smooth holes shall be roughened with a rotohammer before repair. The mortar method of replacement shall be used for holes too wide to dry pack and too shallow for concrete replacement and shall be used for comparatively shallow depressions, large or small, which extend no deeper than the reinforcement nearest the surface. Concrete replacement shall be used when holes extend entirely through the concrete section or when holes are more than one square foot in area and extend halfway through the section. All surfaces of the

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set concrete to be repaired shall first be coated with epoxy bonding agent, Adhesive Engineering Concessive No. 1001 LPL; Sika Chemical Corporation, Sikadur Hi-Mod; or equal. No repair shall be made until the Engineer has accepted the method of preparing the surface and proposed method of repair.

The color of the repair concrete dry pack and grout shall match that of the adjoining concrete. The use of white cement may be required to match color. The Contractor shall prepare test panels for proposed repairs at the beginning of the project for review and approval by the Engineer. This panel will serve as a standard for repairs during the project.

Curing of all repaired concrete shall be the same as specified for concrete.