

SECTION 03051

COLD WEATHER CONCRETING PROCEDURES

PART 1 - GENERAL

1. COLD WEATHER PLACING

A. Protect all concrete work from physical damage or reduced strength which could be caused by frost, freezing actions or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.

B. When the air temperature has fallen to or is expected to fall below 40 degrees F., provide adequate means to maintain the temperature in the area where concrete is being placed at either 70 degrees F., for three (3) days, or 50 degrees F., for five (5) days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Keep protection in place and intact at least 24 hours after artificial heat is discontinued. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.

C. When air temperature has fallen or is expected to fall below 40 degrees F., uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50 degrees F., and not more than 80 degrees F., at point of placement.

D. Do not use frozen material containing ice or snow. Do not place concrete on frozen sub grade or on sub grade containing frozen materials. Ascertain that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow, and ice before placing concrete.

E. Do not use calcium chloride, salt, and other materials containing anti-freeze agents or chemical accelerators, unless otherwise accepted in the mix designs.

SECTION 03052

HOT WEATHER CONCRETING PROCEDURES

PART 1 - GENERAL

1. HOT WEATHER PLACING

- A. Hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- B. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.
- C. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
- D. Use set-control admixtures when required and accepted in mix designs.
- E. Concrete joints, where sawed or formed, shall be filled with joint sealant where floor covering is required.
- F. Dampen sub grade and forms.
- G. Erect windbreaks to reduce concrete surface temperature.
- H. Erect sunshades to reduce concrete surface temperature.
- I. Utilize fogging to cool and moisten surrounding air. Fog nozzles, specially designed for concrete fogging, which produce a fog blanket shall be used. Common garden hose nozzles or other nozzles which produce an excessive washing spray shall not be allowed.

HOT WEATHER CONCRETING PROCEDURES

SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1. DESCRIPTION OF WORK

A. Work under this section consists of furnishing everything necessary for and incidental to the execution and completion of all concrete formwork, as indicated on the drawings and specified herein.

B. The extent of formwork is indicated by the concrete structures shown on the drawings.

C. The work includes providing formwork and shoring for cast-in-place concrete, specifically finished concrete, and installation into formwork of items furnished by others, such as anchor bolts, setting plates, bearing plates, anchorages, inserts, frames, nosings and other items to be embedded in concrete (but not including reinforcing steel).

2. QUALITY ASSURANCE

A. Codes and Standards:

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:

ACI 347: Recommended Practice for Concrete Formwork.
USPS PSI: Product Standard for Softwood Plywood Construction and Industrial.

B. Allowable Tolerances:

- (1) Construct formwork 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.

CONCRETE FORMWORK

3. SUBMITTALS

A. Manufacturer's Data - Concrete Formwork:

For information only, submit two (2) copies of manufacturer's data and installation instructions for proprietary materials including form coatings and manufactured form systems.

PART 2 - PRODUCTS

1. FORM MATERIALS

A. Forms for Exposed Concrete:

Unless otherwise shown or specified, construct form work for exposed concrete surfaces with 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. Provide continuous, straight, smooth as-cast-surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection (minimum $\frac{3}{4}$ inch).

B. Forms for Unexposed Concrete:

Form concrete surfaces which will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is 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:

Provide commercial formulation form coating compounds that 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: 3/4" x 1/8" adhesive backed closed cell tape.

CONCRETE FORMWORK

E. Form Accessories:

Form ties, anchors, and hangers of sufficient strength to completely resist displacement of forms due to construction loads and the depositing of concrete. Provide tie-and-spreader type form ties designed so that no metal will be within one inch of any surface when forms are removed. Where concrete surfaces are exposed to view, do not use form ties which, when removed, will leave a depression larger than one (1) inch in diameter. Use water seal ties in concrete exposed to hydrostatic pressure. Conform to ACI 301 and 347.

- (1) Provide metal inserts for anchorages of materials or equipment to concrete construction, not supplied by other trades and as required for the work. Provide threaded inserts of malleable cast iron, furnished complete with full-depth bolts, $\frac{3}{4}$ " size, unless otherwise shown.
- (2) Provide adjustable wedge inserts of malleable cast iron, complete with bolts, nuts and washers, $\frac{3}{4}$ " bolt size, unless otherwise shown.

F. Screen Chairs:

Metal: wood is not permitted.

G. Corner Chamfer:

Shall be mill run white pine solid material or preformed PVC at all exposed corners of columns, walls and beams.

2. DESIGN OF FORMWORK

A. Design, erect, support, brace and maintain formwork so that it will safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system and in-place construction that has attained adequate strength for that purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation, and position.

B. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, 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. Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

CONCRETE FORMWORK

D. 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. Provide chamber in formwork as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads for long-span members without intermediate supports.

E. Provide temporary openings in wall forms, column forms and at other locations necessary to permit inspection and clean-out.

F. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.

G. Provide formwork 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. Provide a means to seal the bottom of forms at construction joints such as foam tape or other gasket devices.

PART 3 - EXECUTION

1. GENERAL

A. construct forms complying with ACI 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. Use selected materials to obtain required finishes.

B. Fabricate forms for each removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces 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. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms in as inconspicuous location as possible, consistent with project requirements.

CONCRETE FORMWORK

D. Form intersecting planes to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

E. 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.

F. Falsework:

- (1) 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. Construct falsework so that adjustments can be made for take-up and settlement.
- (2) Provide wedges, jacks, or camber strips to facilitate vertical adjustments. Carefully inspect falsework and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce work or required dimensions.

G. Forms for Exposed Concrete:

- (1) Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.
- (2) Do not use metal cover plates for patching holes or defects in forms.
- (3) Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
- (4) Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material which will produce bow.
- (5) Assemble forms to be readily removed without damage to exposed concrete surfaces.
- (6) Form molding shapes, recesses and projections with smooth-finish materials, and install forms with sealed joints to prevent displacement.

CONCRETE FORMWORK

H. Corner Treatment:

- (1) Form exposed corners to produce square, smooth, solid, unbroken lines, except as otherwise shown.
- (2) Form chamfers with $\frac{3}{4}$ " x $\frac{3}{4}$ " strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.
- (3) Unexposed corners may be formed either square or chamfered.

I. Control Joints:

See Section 03302 for treatment of control and construction joints, including wood screeds, metal keyways and sawcuts. Locate as indicate.

J. Provision for Other Trades:

Provide openings in concrete formwork 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. Accurately place and securely support items to be built into forms.

K. Cleaning and Tightening:

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

2. FORM - COATINGS

A. Coat form contact surfaces with form-coating compound before reinforcement is placed. Do not allow excess form coating to accumulate in forms or to come into contact with surface which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with a non-staining, rust-preventive form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3. INSTALLATION OF EMBEDDED ITEMS

A. General:

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. 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:

Set edge forms or bulkheads and intermediate screen strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support types of screen required.

4. SHORES AND SUPPORTS

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

5. REMOVAL OF FORMS

A. General:

Formwork not supporting concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than fifty (50) degrees F. for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided that curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, and slabs and other structural elements may not be removed in less than fourteen (14) days and not until concrete has attained 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. 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.

CONCRETE FORMWORK

6. RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, 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.

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1. DESCRIPTION OF WORK

Work under this section consists of furnishing everything necessary for and incidental to the execution and completion of all concrete reinforcement work, as indicated on the drawings and specified herein. The extent of concrete reinforcement is shown on the drawings and in the schedule. The work includes fabrication and placement of reinforcement for cast-in-place concrete, including bars, ties and supports.

2. QUALITY ASSURANCE

A. Codes and Standards:

Comply with requirements of the latest edition of the following codes and standards, except as herein modified:

- (1) American Welding Society, AWS D1.4-1979, "Standard Welding Code - Reinforcing Steel."
- (2) Concrete Reinforcing Steel Institute, "Recommended Practice for Placing Reinforcing Bars."
- (3) Concrete Reinforcing Steel Institute, "Manual of Standard Practice for Reinforced Concrete Construction."
- (4) American Concrete Institute, ACI 318, "Building Code Requirements for Reinforced Concrete."
- (5) ASTM A615: Specifications for Deformed and Plain Billet-Steel Bars for concrete Reinforcement.
- (6) ACI 315: "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
- (7) ASTM A185: Specifications for Welded Steel Wire Fabric for Concrete Reinforcement.

CONCRETE REINFORCEMENT

3. SUBMITTALS

A. Shop Drawings:

The contractor shall submit to the Owner's Representative four (4) copies of detailed shop drawings showing fabrication, sizes, bending and placement of reinforcing steel proposed for the work, and shall not commence fabrication of the reinforcement until he receives written approval of the shop drawings submitted. Shop drawings shall show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement. Do not scale design drawings or use design drawings for shop drawings. The Contractor shall check contract drawings before starting shop drawings.

B. Approval:

Corrections or comments made on shop drawings during Owner's Representative's review do not relieve the Contractor from compliance with requirements of the drawings and specifications. The review is only for general conformance with the design concept of the project, and Contractor is responsible for confirming and correlating all quantities and dimensions; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

C. Mill Test Reports:

The Contractor shall furnish test reports or an affidavit certifying that the materials or product delivered to the job site meet specified requirements.

4. DELIVERY, HANDLING AND STORAGE

Delivery reinforcement to the project site bundled, tagged, and marked. Use weather-proof tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams. Deliver reinforcement clean, free from loose mill and rust scale, dirt and other coatings. Store concrete reinforcement materials at the site to prevent damage and accumulation of dirt, excessive rust and grease. Exercise care to prevent damage to steel reinforcement during delivery and storage.

PART 2 - PRODUCTS

1. MATERIALS

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:

Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcements in place.

- (1) Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, or concrete block.
- (2) For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
- (3) For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dip galvanized or plastic protected or stainless steel protected legs at Contractor's option.

C. Tie Wire:

Sixteen (16) gauge minimum and in sufficient quantity to hold reinforcement accurately in place during concrete placement operations.

D. Welded Steel Wire Fabric:

Shall conform to the requirements of ASTM A185 and shall be of the size and space opening as designated on the plans.

2. FABRICATION

A. General:

Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice." In case of fabricating errors, do not rebend or straighten reinforcement in a manner that will injure or weaken the material.

B. Unacceptable Materials:

Reinforcement with any of the following defects will not be permitted in the work:

- (1) Bar lengths, depths and bends exceeding specified fabrication tolerances.
- (2) Bend or kinds not indicated on drawings or final shop drawings.
- (3) Bars with reduced cross-section due to excessive rusting or other cause.

C. Identification:

Tie reinforcing bars in bundles and tag with weather-proof tags showing shop drawing numbers.

PART 3 - EXECUTION

1. INSTALLATION

Comply with the Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and support, and as herein specified.

Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

Position, support and secure reinforcement against displacement by formwork, construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

Place reinforcement to obtain the minimum coverages for concrete protection as per ACI 318. Arrange, space and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.

Provide sufficient numbers of supports and of sufficient strength to carry reinforcement. Do not place reinforcing bars more than 2" beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

Provide standard reinforcement splices by lapping ends and placing bars in contact, and tightly wire tying. Comply with requirements of ACI 318 for minimum lap of spliced bars. In the absence of splice locations shown on the drawings, splice top bars at mid-span and bottom bars at supports.

SECTION 03252

ANCHORS AND INSERTS

PART 1 - GENERAL

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.

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.

Inserts shall be clean when installed. After installation, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

PART 2 - PRODUCTS

All inserts shall be made of approved materials and only installed in contact with materials which will not react negatively with inserts.

PART 3 - EXECUTION

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.

Care shall be taken during placement operations so as not to alter the location of any anchors or inserts. After screening operations are complete, the vertical and horizontal alignment shall be rechecked to assure the proper location of anchors and inserts.

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.

ANCHORS AND INSERTS

SECTION 03302

CAST-IN-PLACE CONCRETE/CONCRETE WORK

PART 1 - GENERAL

1. DESCRIPTION OF WORK

Work under this section consists of furnishing everything necessary for the incidental to the execution and completion of all concrete work, as indicated on the drawings and specified herein.

2. QUALITY ASSURANCE

A. Codes and Standards:

- (1) Comply with the provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - (a) ACI 301 "Specifications for Structural Concrete for Buildings".
 - (b) ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".
 - (c) ACI 311 "Recommended Practice for Concrete Inspection".
 - (d) ACI 318 "Building Code Requirements for Reinforced Concrete".
 - (e) Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

B. Workmanship:

The Contractor is responsible for corrections of concrete work which does not conform to the specified requirements, including strength tolerances and finishes. Correct deficient concrete as directed by the Owner's Representative.

C. Submittals:

Contractor shall submit concrete mix data, admixture data, and aggregate to the Engineer for approval before the concrete is poured.

CAST-IN-PLACE CONCRETE/CONCRETE WORK

3. PRODUCT DELIVERY, STORAGE AND HANDLING

A. Reinforcing:

- (1) **Delivery:** Deliver reinforcement clean, free from loose mill and rust scale, dirt and other coating. Deliver reinforcing bars straight, free from twists, kinks, and irregularities except as necessary to conform to reinforcing details.
- (2) **Storage:** Store materials above ground and protect from dirt and grease.
- (3) **Handling:** Exercise care to prevent damage to steel reinforcement during delivery and storage.

B. Concrete Material Storage:

- (1) **Cement:** Store cement in watertight buildings, bins, or silos.
- (2) **Aggregate:** Stockpile aggregate in a manner to prevent contamination with other materials or with sizes of aggregate. To insure this condition, conduct tests for determining conformance to requirements at the point of batching. Allow sand to drain until it has reached a uniform moisture content before it is used.
- (3) **Admixtures:** Store admixtures in a manner to prevent contamination. Protect admixtures from extreme temperatures which would adversely affect their characteristics.

PART 2 - PRODUCTS

All materials used shall conform to the following requirements:

1. CEMENT

All cement used in the work shall be a standard brand of Portland cement and shall comply with the cement A.S.T.M. C150 Standard Specifications for "Air-Entraining Portland Cement".

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.

Different brands, grades, or types of cement must 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 for any reason have become partially set, or which 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.

2. AGGREGATES

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.

A. 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 or 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

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

MORTAR SAND

Sieve Size	Percent Passing
No. 8	100%
No. 50	15- 40%
No. 100	0- 10%

Stone screening will not be used for fine aggregate.

B. 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

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 Inch	100%
3/8 Inch	40-75%
No. 4	0- 5%

C. Sampling and Testing:

Sampling and testing shall be in accordance with the latest revision of the AASHO 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

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 finished concrete. Water from city water supply 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 AASHO Method T-26.

4. ADMIXTURES

A. Air-Entraining Agents:

Air-entrained concrete shall be used in all concrete work at the option of the Contractor, subject to the approval of the Engineer. 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. 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.

PART 3 - CLASSIFICATIONS, STRENGTH REQUIREMENTS AND PROPORTIONS

All concrete shall be of strength or classification specified and/or shown on the plans. When the classification or strength is not expressly indicated, the concrete shall be as stated below. All concrete shall contain not more than six (6) gallons of water to sack of cement including water in aggregates, and not less than six (6) sacks of cement per cubic yard of concrete and have a twenty-eight (28) day compressive strength of at least 4,000 psi. 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.

PART 4 - EXECUTION

1. CONCRETE MIXING

A. General:

Concrete may be mixed at batch plants or it may be transit-mixed as specified herein. Batch plants must comply with requirements of ACI 304, with sufficient capacity to produce concrete of qualities specified in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of Owner's Representative.

CAST-IN-PLACE CONCRETE/CONCRETE WORK

B. Job-Site Mixing:

Concrete mixed at site should conform to the following:

- (1) **General:** Mix concrete in a batch mixer conforming to requirements of mixer manufacturer's Bureau of Associated General Contractors of America. Mixer shall bear manufacturer's rating plate indicating rated capacity and recommended revolutions per minute. Operate mixer in accordance with these recommendations. Use only mixers that are equipped with a suitable charging hopper, water storage tank, water measuring device, and are capable of thoroughly mixing concrete into a uniform mass within the specified mixing time and of discharging the mix without segregation.
- (2) **Admixtures:** When approved for use, 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. Provide suitable agitating equipment to insure uniform distribution of ingredients.
- (3) **Mixing:** 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. Discharge entire batch before recharging.
- (4) **Mixing Time:** 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. Do not exceed 30 minutes total elapsed time between intermingling of damp aggregates and cement to the discharge of the completed mix into forms.
- (5) **Maintenance:** Keep mixer clean. Replace mixer pick-up and throw over blades when they have lost 10 percent of their original depth.

- (6) **Identification:** 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.
- (7) **Ready-Mix Concrete:** 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 C94 may be required. Proposed changes in mixing procedures must be accepted by Owner's Representative before implementation. Plant equipment and facilities should conform to National Ready-Mix Concrete Association "Checklist for Certification of Ready-Mixed Concrete Production Facilities".

C. **Retempering:**

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 will not be permitted unless prior approval is obtained from the Owner's Representative.

2. **FORM PREPARATION**

A. **Pre-Placement Inspection:**

- (1) Before placing concrete, inspect and complete the formwork 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.
- (2) Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used. Where coating is used, apply with a brush or spray covering the form evenly without excess drip. Do not use form oil which causes softening or permanent staining of the concrete.

- (3) Soil at bottom of foundation systems are subject to testing for soil bearing value by the testing laboratory, as directed by the Owner's Representative. 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 poured in areas between slabs on grade previously poured, recheck compaction of subgrade and if necessary, recompact to avoid settlement of slabs at joints. Seal extremely porous subgrades in a manner approved by the Owner's Representative. Remove all ice, debris, and excess water from subgrades. After completion of the concrete work, backfill all excavations in accordance with Section 02200, "Earthwork".
- (4) Coordinate installation of joint materials and moisture barriers with placement of forms and reinforcing steel.
- (5) Installation of anchors, inserts, and sleeves for electrical, mechanical plumbing, heating, ventilating, and air conditioning work is subject to inspection and approval of the supervisors of the particular trades involved. Finish voids in sleeves and inserts temporarily with readily removable material.
- (6) Notify Owner's Representative 24 hours before placing concrete.

3. CONCRETE PLACEMENT

A. General:

Place concrete in compliance with the practices and recommendations of ACI 304, and as specified herein. Do not place any concrete until the Owner's Representative has reviewed the results of the design mix 28 day test breaks and approval is given to proceed.

- (1) Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within joints as herein specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.

- (2) Screed concrete which is to receive other construction to the proper level to avoid excessive shimming or grouting.
- (3) Do not use concrete which becomes nonplastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the project site and dispose of in an acceptable location.

B. Concrete Conveying:

- (1) **General:** Handle concrete from the mixer to place of final deposit as rapidly as practicable and in a manner which will assure that the specified quality of the concrete is obtained.
- (2) **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 Owner's Representative's approval and conform to the following:
 - (a) Truck mixers, agitators and nonagitating units and their manner of operation shall conform to applicable requirements of ASTM C94.
 - (b) Belt Conveyors: Provide conveyors and discharge apparatus of a type which will not cause segregation. Discharge long runs into a hopper.
 - (c) Chutes: Provide metal or metal-lined chutes and install to a slope not exceeding 1 vertical to 3 horizontal. Chutes more than 20 feet long and chutes not meeting the slope requirements may be used provided they discharge into proper hopper.
 - (d) Runways: Provide runways or other means for wheeled equipment to convey the concrete to placement points. Do not support runways on the reinforcement, or wheel equipment over the reinforcement.
 - (e) Pumps: Do not pump concrete without the Owner's Representative's approval. Any change in concrete mix necessitated by pumping must be approved by Owner's Representative prior to placing concrete by this method.

C. Placing Concrete Into Forms:

- (1) 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.
- (2) Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
- (3) 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.
- (4) 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.
- (5) 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.
- (6) Maintain reinforcing steel in the proper position continuously during concrete placement operations.
- (7) Do not drop concrete freely where reinforcing bars will cause segregation, nor drop freely more than six feet. Use tremies in length increments of six feet.

D. Bonding:

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.

4. CONCRETE SURFACE REPAIRS

A. Patching Defective Areas:

- (1) Repair and patch all defective areas with cement mortar immediately after removal of forms, but only when directed by the Owner's Representative.
- (2) Cut out honeycomb and rock pockets, down to concrete but, in no case, to a depth of less than 1 inch. 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 Owner's Representative.
- (3) For exposed-to-view surfaces, 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 locations 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) 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) 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 Owner's Representative. 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 discolorations that cannot be removed by cleaning.

- (2) 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 corner.

C. Repair of Unformed Surfaces:

- (1) Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. 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 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 nonreinforced 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 the 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, by 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 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 Owner's Representative.

D. Use set-control admixtures when required and accepted in mix design.

5. FIELD QUALITY CONTROL AND TESTING

- A. Concrete shall meet or exceed the properties for concrete as defined in the mix design criteria and as herein specified. Failure of the concrete to meet any of these requirements shall be considered grounds for rejection of the concrete or the portion of the work performed with it.
- B. Prior to placing any concrete, the compressive strength shall be verified by making three (3) test cylinders using the proposed mix designs. The cylinders will be tested and the results provided with the mix design submittal.

SECTION 03345

CONCRETE FINISHING

PART 1 - GENERAL

1. FINISH OR FORMED SURFACES

A. Rough Form Finish:

- (1) Provide as-cast rough form finish to formed concrete surfaces that are to be concealed in the finish form or by other construction, unless otherwise indicated.
- (2) Standard rough form finish shall be the concrete surface having the texture imparted by the form facing material used, with tie holes exceeding ¼" in height rubbed down or chipped off.

B. Related Unformed Surfaces:

- (1) At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

- C. After the concrete has set sufficiently so that the coarse aggregate will not become exposed, then the concrete is rubbed, all exposed surfaces will be carborundum rubbed to a smooth, uniform finish. Special care will be taken to maintain sharp, well defined corners on chamber lines. Rounded corners will not be accepted.

2. MONOLITHIC SLAB FINISHES

A. Float Finish:

- (1) Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified or shown on the drawings.

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- (2) After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats or by hand-floating if area is small or inaccessible with power-driven units.

Check and level the surface plane to a tolerance not exceeding $\frac{1}{4}$ " in 10' when tested with a 10' straight edge placed on the surface at not less than 2 different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

B. Non-Slip Broom Finish:

- (1) Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as shown on the drawings.
- (2) Immediately after trowel finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fiber bristle broom unless otherwise directed. Coordinate the required final finish with the Owner's Representative before application.
- (3) Apply non-slip hard aggregate surface to all steps and landings, as shown on the plans. Apply non-slip hard aggregate surface in accordance with manufacturer's recommendations.

CONCRETE FINISHING