

SECTION 3A

CONCRETE FOR BUILDING CONSTRUCTION

1. APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specifications (Fed. Spec.):

SS-S-1401C	Sealant, Joint, Non-Jet-Fuel-Resistant, Hot Applied, for Portland Cement and Asphaltic Concrete Pavements
CCC-C-467C	Cloth, Burlap, Jute (or Kenaf)

1.2 U.S. Department of Commerce, National Bureau of Standards (NBS) Product Standards:

PS 1-83	Construction and Industrial Plywood
American Concrete Institute (ACI) Standards:	
211.1-81	Selecting Proportions for Normal, Heavyweight, and Mass Concrete
301-84	Structural Concrete for Buildings
318-83	Building Code Requirements for Reinforced Concrete Commentary on Building Code Requirements for Reinforced Concrete (ACI-318-83) (First Printing, November 1983)
SP-66	ACI Detailing Manual - 1980
American Society for Testing and Materials (ASTM) Publications:	
A 446-83	Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
A 615-84a	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C 31-84	Making and Curing Concrete Test Specimens in the Field
C 33-84	Concrete Aggregates
C 39-83b	Compressive Strength of Cylindrical Concrete Specimens

C 42-84a	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94-84	Ready-Mixed Concrete
C 143-78	Slump of Portland Cement Concrete
C 150-84	Portland Cement
C 171-69 (Rev 1980)	Sheet Materials for Curing Concrete
C 172-82	Sampling Freshly Mixed Concrete
C 173-78	Air Content of Freshly Mixed Concrete by the Volumetric Method
C 192-81	Making and Curing Concrete Test Specimens in the Laboratory
C 231-82	Air Content of Freshly Mixed Concrete by the Pressure Method
C 260-77	Air-Entraining Admixtures for Concrete
C 309-81	Liquid Membrane-Forming Compounds for Curing Concrete
C 494-82	Chemical Admixtures for Concrete
C 618-84	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
E 96-80	Water Vapor Transmission of Materials

American Welding Society, Inc. (AWS) Publication:

D1.4-79 Structural Welding Code - Reinforcing Steel

National Ready-Mixed Concrete (NRMCA) Association Publication:

Certification of Ready-Mixed Concrete Production Facilities
(Jan 1, 1976)

Truck Mixer Manufacturers Bureau (TMMB) Publication:

Truck Mixer and Agitator Standards (Jan 1, 1981; 10th Rev)

2. GENERAL REQUIREMENTS: Full cooperation shall be given other trades to install embedded items. Before placing concrete, embedded items shall have been inspected, and tests for concrete or other materials or for mechanical

operations shall have been completed and approved. Suitable templates or instructions shall be used for setting items not placed in the forms.

3. SUBMITTALS:

3.1 Shop Drawings: Shop drawings shall be submitted in accordance with the SPECIAL CLAUSES. Shop drawings shall show details of reinforcement, sizes and grades of steel and bending and splicing details.

3.2 Certificates of Compliance: Certificates of compliance attesting that reinforcement meets requirements specified shall be furnished in accordance with the SPECIAL CLAUSES. Certified copies of laboratory test reports, including all test data, shall be submitted for aggregate, admixtures, cement, pozzolan, reinforcement, curing compound, and joint sealer. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturer of the material.

3.3 Submitting Mix Proportions: Prior to commencing operations, the Contractor shall furnish a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete proposed for use. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.

4. STORAGE OF MATERIALS: Cement and pozzolan shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration.

5. MATERIALS: Materials shall conform to the following requirements:

5.1 Admixtures:

5.1.1 Air-entraining admixture shall conform to ASTM C 260.

5.1.2 Water-reducing or retarding admixtures shall conform to ASTM C 494, Type A, B, or D.

5.2 Aggregates: Aggregates for normal weight concrete shall conform to ASTM C 33. Maximum nominal aggregate size shall be 1 inch.

5.3 Anchorage Items: Slots and inserts for anchoring masonry and mechanical items to concrete shall be of standard manufacture. Inserts for

shelf angles and bolt hangers shall be of malleable iron or of cast or wrought steel.

5.4 Cementing Materials: Only one source and type of cement shall be used for exposed concrete surfaces of any structure. Pozzolan may be blended with Type I or II portland cement in an amount not exceeding 20 percent of the combined volume. All pozzolan shall be attained from a single source.

5.4.1 Portland cement shall conform to ASTM C 150, Type I or II.

5.4.2 High-early-strength portland cement shall conform to ASTM C 150, Type III.

5.4.3 Pozzolan shall conform to ASTM C 618, Class N.

5.5 Curing Materials:

5.5.1 Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2 Burlap shall conform to Fed. Spec. CCC-C-467C.

5.5.3 Membrane-forming curing compound shall conform to ASTM C 309, Type 1-D, Class A or B.

5.6 Joint Filler Strips: Contraction joint filler shall consist of hard-pressed fiberboard.

5.7 Joint Sealants: Hot-poured type shall conform to Fed. Spec. SS-S-1401.

Reinforcement: Deformed bars shall conform to ASTM A 615.

Vapor Barrier: Vapor barrier shall be one of the following:

Asphalt-saturated waterproof reinforced kraft paper.

5.9.2 Polyethylene-coated asphalt-saturated reinforced kraft paper.

5.9.3 Polyethylene sheeting shall be at least 6 mils thick.

5.9.4 Other vapor barrier material shall have a vapor permeance rating not exceeding 0.5 perm as determined by ASTM E 96, Procedure E.

5.10 Water: Water shall be potable. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

6. CONCRETE STRENGTH AND USAGE:

6.1 Strength Requirements: Concrete for all work shall have a compressive strength of 3000 psi at 28 days.

6.2 High Early Strength: Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement.

7. PROPORTIONING OF NORMAL WEIGHT CONCRETE MIXES: Mixes shall be proportioned by weight, although water and admixtures may be batched by volume if desired. Trial mixes and testing to meet requirements of the strengths of concrete specified shall be the responsibility of the Contractor. The design mix shall contain materials representative of those proposed for use in the work.

7.1 Admixtures: Concrete exposed to freeze-thaw-cycles shall contain from 5 to 7 percent entrained air as determined by ASTM C 231. Air-entrained concrete also may be used in other parts of the work. Water reducing or set retarding admixtures may be used when approved, provided the cement content is not reduced.

7.2 Slump: Slump shall be determined in accordance with ASTM C 143, and shall be within the following limits:

Element	Slump, Inches	
	Minimum	Maximum
Walls 12 inch maximum thickness	2	4
Floors, exterior slabs and other building construction	1	3

Where pumping is approved, the maximum slump may be increased to 5 inches, except for floors and exterior slabs.

7.3 Mix Design: Trial mixes having proportions, air content and slump suitable for the work shall be based on ACI 301, using at least three different water-cement ratios which will produce a range of strength encompassing that required for the work. The mixes shall be designed for maximum permitted air and slump. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. Test cylinders shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength. For each strength of concrete, the maximum allowable water-cement ratio shall be that shown by these curves to produce an average compressive strength 15 percent greater than specified.

8. SAMPLING AND TESTING DURING CONSTRUCTION:

8.1 General: Testing is the responsibility of the Contractor and shall be performed by an approved testing agency at no additional cost to the Government.

8.2 Aggregates: Aggregates shall be tested as prescribed in ASTM C 33.

8.3 Admixtures: Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used until proved by retest to be satisfactory.

8.4 Tests on Fresh Concrete: Tests for slump and air content shall be made on concrete sampled at the form. One test per day, minimum.

8.5 Concrete Strength Tests:

8.5.1 Frequency of Testing: The Contractor shall provide, for strength tests, concrete specimens. Samples for strength tests of concrete placed each day shall be taken not less than once a day nor less than once for each 250 cubic yards of concrete. When the total quantity of a given strength of concrete is less than 100 cubic yards, the strength tests may be waived by the Contracting Officer if adequate evidence of satisfactory strength is provided.

8.5.2 Testing Procedures: The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C31. Procedures for field curing and protection of test cylinders to check the adequacy of the curing and protection of the concrete in the structure, or to determine form removal time shall be in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39 by an approved testing laboratory at no cost to the Government. Each strength test result shall be the average of two cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved.

8.5.3 Evaluation of Results: Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the required strength by more than 500 psi. If any of these requirements are not met, steps shall be taken immediately to raise the strength level.

8.5.4 Strength Tests: Strength tests of field cured specimens shall be made when directed, to check the adequacy of curing and protection of concrete in the structure.

8.6 Tests of Concrete in the Structure: When the results of the strength tests on control cylinders indicate that the concrete in place does not meet specification requirements, or if tests of field-cured cylinders indicate deficiencies in protection and curing, cores shall be drilled and tested in accordance with ASTM C 42. The cores shall be drilled at locations designated by the Contracting Officer, and shall be tested by and at the expense of the Contractor. If the results of the tests indicate that the concrete in place conforms to the specified strength within the tolerances stated in ACI 318, the cost of the tests will be borne by the Government. If the results indicate that the concrete does not meet the specified strength within the tolerances stated in ACI 318, the cost of the tests will be borne by the Contractor; in this case the Contractor shall correct the deficiency or he may submit a proposal for a load test. If this proposal is approved, the load test shall be conducted by the Contractor at his expense,

and the test results will be evaluated by the Contracting Officer in conformance with ACI 318 and Commentary on Building Code Requirements for Reinforced Concrete (ACI-318-77). If any concrete fails to meet all of the requirements of the load test, the deficiency shall be corrected in a manner satisfactory to the Contracting Officer and at no additional cost to the Government.

9. FORM WORK: Form work shall be designed and constructed so as to insure that the finished concrete members will conform accurately to the indicated dimensions, lines and elevations.

9.1 Design: Studs and wales shall be spaced to prevent deflection of form sheeting. Forms shall be sufficiently tight to prevent leakage of grout and cement paste during placing of the concrete. The bottom of forms shall be accurately fitted and securely attached to the preceding lift so as to assure smooth, completed surfaces free from irregularities and offsets. Joints between form work panels shall be arranged vertically and horizontally to match architectural lines, vertical control joints and construction joints. Temporary openings shall be provided in wall and column forms where needed to facilitate cleaning and inspection. Forms shall be readily removable without impact or damage to the concrete.

9.2 Concrete Surfaces Not Exposed to View: Concrete surfaces which will not be exposed to view in the finished work shall be formed with sound, tight lumber or other material producing equivalent finish.

9.3 Concrete Surfaces Exposed: Concrete surfaces to be exposed shall be formed with a material that is not reactive with concrete. Surfaces shall be equivalent in smoothness and appearance to that produced by new plywood panels conforming to PS 1, Exterior Type, Grade B-B, plyform 5/8-inch thick. Panels shall be 4 by 8 feet except where otherwise approved or required by the location of openings, architectural lines or joints. Cut surfaces shall be treated with form coating. Form materials with defects that would impair the texture and appearance of finish surfaces shall not be used. Form lining, if used, shall be installed over solid backing.

9.4 Form Ties: Form ties shall be factory-fabricated, removable or snap-off metal ties of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Ties shall be fitted with devices that will leave holes in the concrete surface not less than 1/4 inch nor more than 1 inch in diameter and not more than 1 inch deep. That portion of the tie remaining permanently in the concrete shall not project beyond the surface of the concrete and shall be at least 1 inch back from any concrete surfaces that will be exposed, painted, dampproofed, or will receive direct applications of plaster. Bolts and rods that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

9.5 Chamfering: External corners of foundation walls projecting beyond other external corners that will be exposed, shall be chamfered, bevelled, or rounded, by moldings placed in the forms unless the drawings specifically state that chamfering is to be omitted.

9.6 Form Coating: Forms shall be coated with form oil or form-release agent before reinforcement is placed. The coatings shall be a commercial formulation of satisfactory and proven performance that will not bond with, stain or adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compound. Forms for unexposed surfaces may be wet with water in lieu of oiling, immediately before placing concrete, except that in cold weather with probable freezing temperatures oiling shall be mandatory. Surplus oil on form surfaces, reinforcing steel and construction joint shall be removed before placing concrete.

9.7 Removal of Forms: Forms shall be removed in a manner that will prevent injury to the concrete and insure the complete safety of the structure. Wall forms, and similar vertical forms may be removed after 24 hours, provided the concrete is sufficiently strong not to be injured thereby. No forms shall be removed until the structure has sufficient strength to support safely its weight and the loads placed thereon. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured specimens shall be provided in numbers as directed and shall be in addition to those required for concrete control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

10. REINFORCEMENT: Reinforcement shall be fabricated to the shapes and dimensions shown, and shall be placed where indicated. Reinforcing steel shall not be bent or straightened in a manner injurious to steel or to the concrete. Bars with kinks or bends not shown on the drawings shall not be placed. The use of heat to bend or straighten reinforcing steel will not be permitted. Bars shall be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, the resulting arrangement of bars including additional bars necessary to meet structural requirements shall be approved before concrete is placed. Reinforcing steel shall not be spliced at points of maximum stress unless otherwise indicated. Laps or splices shall conform to ACI 318. Welding shall comply with AWS D1.4. Tack welding to, or of, reinforcement is prohibited. Reinforcement shall be free from loose or flaky rust and mill scale, except tight mill scale, or any other coating which might reduce the bond to concrete. After any substantial delay in the work previously placed, reinforcing steel left for future bonding shall be inspected and cleaned.

10.1 Reinforcement Detailing and Placement: Reinforcement detailing and placement shall conform to ASI 318 and ACI SP-66, except where otherwise indicated.

10.2 Supports: Supports shall be provided in conformance with the ACI SP-66 detailing manual, unless otherwise indicated or specified. Wire ties, when used, shall be 16-gage black annealed wire and shall have ends pointing away from the forms. Bar supports for formed surfaces exposed to view shall

be plastic protected wire, stainless steel or precast concrete. Precast concrete supports shall be wedge-shaped, not larger than 3-1/2 by 3-1/2 inches, of thickness necessary to produce the required concrete cover, and with an embedded hooked tie wire for anchorage. If the formed surface is exposed to view, the concrete shall be the same quality, texture and color as the finish surface. On ground, precast concrete supports shall be used.

11. CONSTRUCTION JOINTS: Construction joints in concrete other than slabs on grade: The unit of operation shall not exceed 50 feet for foundation walls and other foundation work except footings. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjoining units until they are at least 24 hours old. Joints not indicated shall be in accordance with ACI 318 or as noted below. In walls having door openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as indicated or as to conform to structural requirements or architectural details. Where horizontal construction joints are required, a strip of 2-inch square-edged lumber, bevelled to facilitate removal and oiled, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1-1/2 inches above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, any irregularities in the joint line leveled off with a wood float, and all laitance removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph PREPARATIONS FOR PLACING CONCRETE.

12. INSTALLATION OF ANCHORAGE ITEMS: Anchorage items shall be of sufficient number and size, and shall be located to serve the intended purpose.

13. PREPARATION FOR PLACING CONCRETE:

13.1 General: Water shall be removed from the excavation before placing concrete. Any flow of water shall be diverted through side drains without washing over freshly deposited concrete. Hardened concrete, debris, and foreign material shall be removed from the interior of forms. Runways shall be provided for wheeled concrete-handling equipment; such equipment shall not be wheeled over reinforcement nor shall runways be supported on reinforcement. Reinforcement and embedded items shall be inspected, and forms shall be retightened and checked, before placing concrete.

13.2 Concrete on Earth and Rock Foundations: Earth and rock foundations shall be prepared as specified in SECTION: EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. Care shall be taken not to disturb the prepared foundations. Surfaces shall be clean and free from frost, ice, mud, and water.

13.2.1 Vapor barrier materials shall be laid over dry or pervious surfaces to receive concrete slabs. Concrete footings and exterior slabs may be laid directly on impervious surfaces which are thoroughly moistened but not muddy at the time of concrete placement.

13.2.2 Immediately before concrete is placed, hard rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved method. Soft rock foundations shall be treated as described above for earth foundations. Rocks of other hardness, or of variable hardness, shall be treated as directed.

13.3 Bonding to Hardened Concrete: Horizontal construction joints shall be prepared by roughening the surface of the concrete in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles or aggregate of damaged concrete at the surface. The surfaces shall be moist but without free water when concrete is placed.

14. BATCHING, MIXING AND TRANSPORTING CONCRETE: Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and non-agitating units shall comply with TMMB "Truck Mixer and Agitator Standards". Plant equipment and facilities shall conform to NRMCA "Certification of Ready Mixed Concrete Production Facilities".

14.1 Admixtures: Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible.

14.2 Control of Mixing Water: All materials shall be batched at the plant. However, where approved by the Contracting Officer, water may be added at the jobsite when the slump is less than specified and the water-cement ratio is less than the approved mix design permits. In this case, water may be added to bring the slump within the specified range without exceeding the approved water-cement ratio. The water shall be injected into the mixer under pressure, and the drum or blades turned a minimum of 30 additional revolutions at mixing speed. There shall be no further addition of water to the batch.

14.3 Site-Mixed Concrete: Site-mixed concrete shall comply with ACI 301.

15. CONVEYING CONCRETE: Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph PLACING CONCRETE by methods which will prevent segregation or loss of ingredients.

15.1 Chutes: When concrete can be placed directly from a truck mixer or other transporting equipment, the chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.

15.2 Buckets: The bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

15.3 Belt Conveyors: Belt conveyors may be used when approved. Conveyors shall be designed and operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar, and shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement.

15.4 Pumps: Concrete may be conveyed by positive displacement pumps when approved. The concrete mix shall be designed for pumping. The pump shall be the piston or squeeze pressure type. The pipeline shall be steel pipe or heavy duty flexible hose. The inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. The distance to be pumped shall not exceed the limits recommended by the pump manufacturer. The concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each operation, the equipment shall be thoroughly cleaned, and flushing water shall be wasted outside the forms.

16. PLACING CONCRETE

16.1 General: Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12-inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting. Conduits and pipes shall not be embedded in concrete except where specifically indicated or approved.

16.2 Consolidation: Immediately after placing, each layer of concrete shall be consolidated by internal vibrators. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrations shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mix being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. It shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall not be

consolidated by internal vibration; properly designed vibrating screeds or other approved techniques shall be used.

16.3 Time Interval Between Mixing and Placing: Mixed concrete which is transported in truck mixers or agitators, or concrete which is truck mixed, shall be discharged within 1-1/2 hours after introduction of the cement to the aggregates, except that when the concrete temperature exceeds 85 degrees Fahrenheit, this time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

16.4 Cold Weather Requirements: Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be maintained at not less than 40 degrees Fahrenheit. The temperature of the concrete when placed shall be not less than 50 degrees Fahrenheit nor more than 75 degrees Fahrenheit. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing.

16.5 Warm Weather Requirements: Concrete placed during warm weather shall have the lowest temperature practicable to produce under the conditions. The temperature of the concrete as placed shall not exceed 85 degrees Fahrenheit except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95 degrees Fahrenheit.

17. TREATMENT OF FORMED SURFACES: Within 24 hours after forms are removed, surface defects shall be remedied as specified herein. For permanently exposed surfaces, fins shall be removed and holes left by removal of tie rods shall be reamed and filled by dry-packing. For all surfaces, honeycomb and other defective areas shall be cut back to sound concrete and to a depth of not less than 1 inch. The edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be dampened and brush-coated with neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 45 minutes and then remixed, thoroughly tamped into place; in lieu of hand patching, a small shotcrete gun may be used. Patches shall be finished flush with adjacent surfaces. For surfaces permanently exposed to view, the cement used shall be a blend of job cement with white cement proportioned so that the final color after curing will be the same as the adjacent concrete. The temperature of concrete, mortar patching material and ambient air shall be above 50 degrees Fahrenheit while making the repair and during the ensuing 72 hours moist curing period. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected or the defects shall be corrected as directed by the Contracting Officer.

18. FLOOR SLABS ON GRADE:

18.1 Capillary Vapor Barrier: Immediately before placing concrete, the capillary water barrier or subgrade under slabs in buildings shall be covered with a vapor barrier unless membrane waterproofing is indicated. Punctures and tears during subsequent operations shall be patched. Edges shall be lapped and joints shall be sealed with a pressure-sensitive adhesive or pressure-sensitive tape, not less than 2 inches wide and compatible with the membrane.

18.2 Placement: Placement of concrete shall be continuous so that each unit of operation will be monolithic. Concrete shall be consolidated, screeded to grade, and prepared for the specified finish. Forms shall remain in place for at least 24 hours after concrete placement.

19. FINISHING CONCRETE FLOOR SLABS: In cold weather, the air temperature in areas where concrete is being finished shall not be less than 50 degrees Fahrenheit. In hot windy weather, a covering or windbreaks shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 1/8 inch when tested with a 10-foot straightedge.

19.1 Rough Slab Finish: Immediately after consolidation, slabs shall be screeded with straightedges to bring the surface to the required finish level with no coarse aggregate visible.

19.2 Wood-Float Finish: The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened so that it will withstand a man's weight without imprint and the water sheen has disappeared, it shall be wood floated.

19.3 Steel Trowel Finish: Immediately following the wood floating, the surface shall be steel-trowelled to produce a smooth, dense surface free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand.

20. CURING AND PROTECTION:

20.1 General: All concrete shall be cured by an approved method for the period of time given below:

Type I or II	7 days
Type I or Type II cement blended with pozzolan	12 days

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. All materials and equipment needed

for adequate curing and protection shall be available and at the placement prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

20.2 Moist Curing: Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If the water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2-inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

20.3 Membrane Curing: Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared. The compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method at the coverage herein specified. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

20.4 Cold Weather: The air and forms in contact with concrete shall be maintained at a temperature above 50 degrees Fahrenheit for the first 3 days and at a temperature above 32 degrees Fahrenheit for the remainder of the specified curing period.

21. SAND-CEMENT GROUT: Sand-cement grout shall consist of 1 part cement and 2 parts fine aggregate as specified in paragraph MATERIALS, mixed with enough water to insure a workable consistency.