
USACE / NAVFAC / AFCEC UFGS-03 30 53 (May 2014)

Preparing Activity: USACE

Superseding
UFGS-03 30 53 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2025

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DIVISION 03 - CONCRETE

SECTION 03 30 53

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SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE
05/14

NOTE: This guide specification covers the requirements for projects involving amounts of concrete less than **380 cubic meters**. This section may not be applicable to NAVFAC projects without extensive editing to meet NAVFAC requirements.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: This specification requires furnishing all material and equipment, and performing all labor for the manufacturing, transporting, placing, finishing, and curing of concrete for recreation sites, road relocations, or other structures such as culvert headwalls, comfort stations, residences, or low head gate structures. Consideration should be given to using Section **03 30 00** CAST-IN-PLACE CONCRETE when the quantity of concrete is **380 cubic meters** or greater per structure.

1.1 SUMMARY

Perform all work in accordance with **ACI 318M**.

1.2 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 301	(2020) Specifications for Structural Concrete
ACI 301M	(2020) Metric Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 318M	(2019; Errata 2022) Building Code Requirements for Structural Concrete & Commentary
ACI 347R	(2014; Errata 1 2017) Guide to Formwork

for Concrete

ACI SP-66

(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M

(2024) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A1064/A1064M

(2024) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM C31/C31M

(2025a) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C33/C33M

(2024a) Standard Specification for Concrete Aggregates

ASTM C39/C39M

(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C94/C94M

(2025) Standard Specification for Ready-Mixed Concrete

ASTM C143/C143M

(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C150/C150M

(2024) Standard Specification for Portland Cement

ASTM C172/C172M

(2017) Standard Practice for Sampling Freshly Mixed Concrete

ASTM C173/C173M

(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C231/C231M

(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C260/C260M

(2024) Standard Specification for Air-Entraining Admixtures for Concrete

ASTM C309

(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C494/C494M

(2024) Standard Specification for Chemical Admixtures for Concrete

ASTM C595/C595M

(2024) Standard Specification for Blended Hydraulic Cements

ASTM C618

(2025a) Standard Specification for Coal

	Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C920	(2018; R 2024) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D98	(2015) Calcium Chloride
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a; R 2021) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E96/E96M	(2024a) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E1155	(2020) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1155M	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers (Metric)
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with

Earth or Granular Fill Under Concrete Slabs

ASTM E1745 (2017; R 2023) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

ASTM E1993/E1993M (1998; R 2020) Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513 (1974) Corps of Engineers Specifications for Rubber Waterstops

COE CRD-C 572 (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

KOREAN INDUSTRIAL STANDARDS (KS)

KS D 3504 (2025) Steel Bars for Concrete Reinforcement

KS D 7017 (2023) Welded Wire Mash and Bar Fabrics

KS F 2401 (2017; R 2022) Standard Test Method for Sampling of Fresh Concrete

KS F 2402 (2022) Test Method for Concrete Slump

KS F 2403 (2019; R 2024) Standard Test Method for Making Concrete Specimens

KS F 2405 (2022) Test Method for Compressive Strength of Concrete

KS F 2421 (2016; R 2021) Method of Test for Air Content of Fresh Concrete by Pressure Method

KS F 2449 (2022) Test Method for Air Content of Fresh Concrete by the Volumetric Method

KS F 2501 (2017; R 2022) Standard Test Method for Sampling Aggregates

KS F 2527 (2024) Aggregates for Concrete

KS F 2538 (2021) Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction

KS F 2540 (2020) Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete

KS F 2560 (2019; R 2024) Chemical Admixtures for Concrete

KS F 4007	(2002; R 2022) Sheet Materials for Curing Concrete
KS F 4009	(2024) Ready-Mixed Concrete
KS F 4910	(2021) Sealants for Sealing and Glazing in Buildings
KS F 4924	(2021) Plastic Films Vapour Barrier for Buildings
KS L 5201	(2021) Portland Cement
KS L 5405	(2023) Fly Ash
KS M 3805	(2018; R 2023) Polyvinylchloride Waterstop

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy and Air Force projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Air-Entraining Admixture

Accelerating Admixture

Water-Reducing or Retarding Admixture

Curing Materials

Expansion Joint Filler Strips, Premolded

Joint Sealants - Field Molded Sealants

Waterstops

Chemical Floor Hardener

Batching and Mixing Equipment

Conveying and Placing Concrete

Formwork

Mix Design Data; G

Ready-Mix Concrete

Curing Compound

Mechanical Reinforcing Bar Connectors

SD-06 Test Reports

Aggregates

Concrete Mixture Proportions; G

Measurement of Floor Tolerances

Compressive Strength Testing; G

Slump; G

Air Content

Water

SD-07 Certificates

Cementitious Materials

Aggregates

Delivery Tickets

SD-08 Manufacturer's Instructions

Chemical Floor Hardener

Curing Compound

1.4 QUALITY ASSURANCE

Indicate specific locations of Concrete Placement, Forms, Steel Reinforcement, Accessories, and Joints on [installation drawings](#) and include, but not be limited to, square [meters](#) of concrete placements, thicknesses and widths, plan dimensions, and arrangement of cast-in-place concrete section.

1.4.1 Flatness and Levelness of Floor Slabs

Conduct floor flatness and levelness test, (FF and FL respectively), on floor slabs in accordance with the provisions set forth in [ASTM E1155M](#) or [ASTM E1155](#). Make floor tolerance measurements by the approved laboratory and inspection service within 24 hours after completion of final troweling operation and before forms and shores have been removed. Provide results of floor tolerance tests, including formal notice of acceptance or rejection of the work, to the Contracting Officer within 24 hours after data collection.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The Government retains the option to sample and test joint sealer, joint filler material, waterstop, aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Obtain samples of aggregates at the point of batching in accordance with [ASTM D75/D75M](#) or [KS F 2501](#). Sample concrete in accordance with [ASTM C172/C172M](#) or [KS F 2401](#). Determine slump and air content in accordance with [ASTM C143/C143M](#) or [KS F 2402](#) and [ASTM C231/C231M](#) or [KS F 2421](#), respectively, when cylinders are molded. Prepare, cure, and transport compression test specimens in accordance with [ASTM C31/C31M](#) or [KS F 2403](#). Test compression test specimens in accordance with [ASTM C39/C39M](#) or [KS F 2405](#). Take samples for strength tests not less than once each shift in which concrete is produced from each strength of concrete required. Provide a minimum of four [150 x 300 mm](#) specimens from each sample; two [150 x 300 mm](#) to be tested at 28 days (90 days if pozzolan or slag cement is used) for acceptance. Two [150 x 300mm](#) or three will be tested at 7 days for information.

2.1.1 Strength

Acceptance test results are the average strengths of two [150 x 300 mm](#) specimens tested at 28 days (90 days if pozzolan or slag cement is used). The strength of the concrete is considered satisfactory so long as the average of all three consecutive acceptance test results equal or exceed

the specified compressive strength, f'_c , and no individual acceptance test result falls below f'_c by more than 3.4 MPa.

2.1.1.2 Construction Tolerances

Apply a Class "C" finish to all surfaces except those specified to receive a Class "D" finish. Apply a Class "D" finish to all post-construction surfaces which will be permanently concealed. Surface requirements for the classes of finish required are as specified in ACI 117.

2.1.1.3 Concrete Mixture Proportions

NOTE: The nominal maximum size of the coarse aggregate is as specified in ACI 318, Chapter 3 and ACI 318M. Guidelines for the maximum water cementitious material ratio and air content can be found in ACI 318 Chapter 4.

Concrete mixture proportions are the responsibility of the Contractor. Mixture proportions must include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic meter of concrete. Provide materials included in the mixture proportions of the same type and from the same source as will be used on the project. The specified compressive strength f'_c is [indicated in drawings] [20.7][_____] MPa at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate shall be in accordance with ACI 304R. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings. The air content must be between 4.5 and 7.5 percent with a slump between 50 and 125 mm. The maximum water-cementitious material ratio is 0.50. Submit the applicable test reports and mixture proportions that will produce concrete of the quality required, ten days prior to placement of concrete.

2.1.1.4 Slag Cement

Slag Cement must conform to ASTM C989/C989M.

2.2 MATERIALS

Submit manufacturer's literature from suppliers which demonstrates compliance with applicable specifications for the specified materials.

2.2.1 Cementitious Materials

Submit Manufacturer's certificates of compliance, accompanied by mill test reports, attesting that the concrete materials meet the requirements of the specifications in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE".

2.2.1.1 Portland Cement

NOTES: Limit the use of air-entraining cement to concrete placements where separate batching of air-entraining admixture is not practical.

If high early strength concrete is required, specify Type III after consulting the agency's Subject Matter Expert in Concrete Materials.

Tricalcium aluminate, for sulfate resistance, is limited to Type III cement. If high early strength is not required, specify Type II rather than Type I when moderate sulfate resistance is required, or Type V when high sulfate resistance is required.

Specify low-alkali cement when the aggregate is either silica or carbonate reactive.

ASTM C150/C150M or KS L 5201, Type I,II, or V.

2.2.1.2 Blended Hydraulic Cement

NOTES: Limit the use of air-entraining cement to concrete placements where separate batching of air-entraining admixture is not practical.

Specify low-alkali cement when reactive aggregates are to be used.

Provide blended cement conforming to ASTM C595/C595M and ASTM C1157/C1157M, Type IP, IL or IS.

2.2.1.3 Pozzolan

Provide pozzolan that conforms to ASTM C618, Class F, including requirements of Tables 1A and 2A; or conforms to KS L 5405.

2.2.2 Aggregates

NOTE: This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of concrete (less than 190 cubic meters).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph ALKALI-SILICA REACTIVITY, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project, in which case the lower limit is required by the application

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate).

For fine and coarse aggregates meet the quality and grading requirements of ASTM C33/C33M or KS F 2527. Submit certificates of compliance and test reports for aggregates showing the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

2.2.3 Admixtures

Provide admixtures, when required or approved, in compliance with the appropriate specification listed. Retest chemical admixtures that have been in storage at the project site, for longer than 6 months or that have been subjected to freezing, at the expense of the Contractor at the request of the Contracting Officer and will be rejected if test results are not satisfactory.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture that meets the requirements of ASTM C260/C260M or KS F 2560.

2.2.3.2 Accelerating Admixture

Provide calcium chloride meeting the requirements of ASTM D98. Other accelerators must meet the requirements of ASTM C494/C494M, Type C or E or KS F 2560.

2.2.3.3 Water-Reducing or Retarding Admixture

Provide water-reducing or retarding admixture meeting the requirements of ASTM C494/C494M, Type A, B, or D.

2.2.4 Water

Mixing and curing water in compliance with the requirements of ASTM C1602/C1602M or KS F 4009, Appendix B; free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M or KS F 4009, Appendix B.

2.2.5 Reinforcing Steel

**NOTE: Delete this paragraph if fibercrete is
accepted for use by the Contracting Officer.**

Provide reinforcing bars conforming to the requirements of [ASTM A615/A615M](#) or [KS D 3504](#), Grade 60, deformed. Provide welded steel wire reinforcement conforming to the requirements of [ASTM A1064/A1064M](#) or [KS D 7017](#). Detail reinforcement not indicated in accordance with [ACI 301M](#) and [ACI SP-66](#). Provide [mechanical reinforcing bar connectors](#) in accordance with [ACI 301M](#) and provide 125 percent minimum yield strength of the reinforcement bar.

2.2.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded of sponge rubber conforming to [ASTM D1752](#), Type I; or [KS F 2538](#).

2.2.7 Joint Sealants - Field Molded Sealants

**NOTES: Use ASTM C920 for field-molded sealants in
small hydraulic structures.**

Conform to [ASTM C920](#) or [KS F 4910](#), Type M, Grade NS, Class 25, use NT for vertical joints and Type M, Grade P, Class 25, use T for horizontal joints. Provide polyethylene tape, coated paper, metal foil, or similar type bond breaker materials. The backup material needs to be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, clean the joint of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

2.2.8 Formwork

Design and engineer the formwork as well as its construction in accordance with [ACI 301M](#) Section 2 and 5 and [ACI 347R](#). Fabricate of wood, steel, or other approved material. Submit formwork design prior to the first concrete placement.

2.2.9 Form Coatings

Provide form coating in accordance with [ACI 301M](#).

2.2.10 Vapor Retarder and VaporBarrier

Provide vapor retarders conforming to [ASTM E1745](#) Class C or [KS F 4924](#) polyethylene sheeting, minimum 0.25 mm thickness or other equivalent material with a maximum permeance rating of 0.04 perms per [ASTM E96/E96M](#). Provide vapor barrier conforming to [ASTM E1745](#) Class C or [KS F 4924](#) polyethylene sheeting, minimum 0.38 mm thickness or [ASTM E1993/E1993M](#) bituminous membrane or other equivalent material with a maximum permeance rating of 0.01 perms per [ASTM E96/E96M](#).

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.2.11 Curing Materials

Provide curing materials in accordance with **ACI 301M**, Section 5.

2.3 READY-MIX CONCRETE

Provide ready-mix concrete with **mix design data** conforming to **ACI 301M** Part 4. Submit **delivery tickets** in accordance with **ASTM C94/C94M** or **KS F 4009** for each ready-mix concrete delivery, include the following additional information: .

- a. Type and brand cement
- b. Cement content in **43 kilogram** bags per cubic **meter** of concrete
- c. Maximum size of aggregate
- d. Amount and brand name of admixture
- e. Total water content expressed by water cementitious material ratio

2.4 ACCESSORIES

2.4.1 Waterstops

2.4.1.1 PVC Waterstop

Polyvinylchloride waterstops conforming to **COE CRD-C 572** or **KS M 3805**.

2.4.1.2 Rubber Waterstop

Rubber waterstops conforming to **COE CRD-C 513**.

2.4.1.3 Thermoplastic Elastomeric Rubber Waterstop

Thermoplastic elastomeric rubber waterstops conforming to **ASTM D471**.

2.4.1.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water conforming to **ASTM D412** as follows:
Tensile strength **2.9 MPa** minimum; ultimate elongation 600 percent minimum. Minimum hardness of 50 on the type A durometer and the volumetric expansion ratio in distilled water at **20 degrees C**; 3 to 1 minimum.

2.4.2 Chemical Floor Hardener

Provide hardener which is a colorless aqueous solution containing a blend of inorganic silicate or silicate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

2.4.3 Curing Compound

Provide curing compound conforming to **ASTM C309** or **KS F 2540**. Submit manufactures instructions for placing curing compound.

PART 3 EXECUTION

3.1 PREPARATION

Prepare construction joints to expose coarse aggregate. The surface must be clean, damp, and free of laitance. Construct ramps and walkways, as necessary, to allow safe and expeditious access for concrete and workmen. Remove snow, ice, standing or flowing water, loose particles, debris, and foreign matter. Satisfactorily compact earth foundations. Make spare vibrators available. Placement cannot begin until the entire preparation has been accepted by the Government.

3.1.1 Embedded Items

Secure reinforcement in place after joints, anchors, and other embedded items have been positioned. Arrange internal ties so that when the forms are removed the metal part of the tie is not less than 50 mm from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Prepare embedded items so they are free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete is permitted only when specifically authorized or directed. Provide all equipment needed to place, consolidate, protect, and cure the concrete at the placement site and in good operating condition.

3.1.2 Formwork Installation

Forms must be properly aligned, adequately supported, and mortar-tight. Provide smooth form surfaces, free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all exposed joints and edges , unless otherwise indicated.

3.1.3 Vapor Retarder and Vapor Barrier Installation

**NOTE: Use a vapor barrier only when it is desirable
to prevent migration of moisture through slabs of
buildings.**

Install in accordance with ASTM E1643. Apply vapor retarder and barrier over gravel fill. Lap edges not less than 300 mm. Seal all joints with pressure-sensitive adhesive not less than 50 mm wide. Protect the vapor barrier at all times to prevent injury or displacement prior to and during concrete placement.

3.1.4 Production of Concrete

3.1.4.1 Ready-Mixed Concrete

Provide ready-mixed concrete conforming to ASTM C94/C94M or KS F 4009 except as otherwise specified.

3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Conform to ASTM C685/C685M.

3.1.4.3 Batching and Mixing Equipment

The option of using an on-site batching and mixing facility is available. The facility must provide sufficient batching and mixing equipment capacity to prevent cold joints. Submit the method of measuring materials, batching operation, and mixer for review, and manufacturer's data for batching and mixing equipment demonstrating compliance with the applicable specifications. Provide an Onsite Plant conforming to the requirements of either ASTM C94/C94M or KS F 4009 or ASTM C685/C685M.

3.1.5 Waterstops

Install and splice waterstops as directed by the manufacturer.

3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301M, Section 5.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R.

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R.

3.3 FINISHING

3.3.1 Temperature Requirement

Do not finish or repair concrete when either the concrete or the ambient temperature is below 10 degrees C.

3.3.2 Finishing Formed Surfaces

Remove all fins and loose materials, and surface defects including filling of tie holes. Repair all honeycomb areas and other defects. Remove all unsound concrete from areas to be repaired. Ream or chip surface defects greater than 13 mm in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete and fill with dry-pack mortar. Brush-coat the prepared area with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. Use a blend of portland cement and white cement in mortar or concrete for repairs to all surfaces permanently exposed to view so that the final color when cured is the same as adjacent concrete.

3.3.3 Finishing Unformed Surfaces

Finish unformed surfaces in accordance with ACI 301M, Section 5.

Float finish all unformed surfaces, that are not to be covered by additional concrete or backfill, to elevations shown, unless otherwise specified. Surfaces to receive additional concrete or backfill shall be brought to the elevations shown and left as a true and regular surface.

Apply a trowel finish to building slabs to be left exposed or covered with tiles. Trowelling shall be done immediately following floating to provide a smooth, even, dense finish free from blemishes including trowel marks.

Apply a broom finish as indicated. Screed and float the concrete to required finish plane with no coarse aggregate visible. After surface moisture disappears, broom or brush the surface with a broom or fiber bristle brush in a direction transverse to that of the main traffic or as directed.

Finish unformed surfaces to a tolerance of 10 mm for a float finish and 8 mm for a trowel finish as determined by a 3 m straightedge placed on surfaces shown on the drawings to be level or having a constant slope. Do not perform finishing while there is excess moisture or bleeding water on the surface. No water or cement is to be added to the surface during finishing.

3.3.3.1 Measurement of Floor Tolerances

Test floor slabs within 24 hours of the final troweling. Submit test results to Contracting Officer within 12 hours after collecting data. Floor flatness inspector must provide a tolerance report which includes:

- a. Name of Project
- b. Name of Contractor
- c. Date of Data Collection
- d. Date of Tolerance Report
- e. A Key Plan Showing Location of Data Collected
- f. Results Required

3.3.3.2 Expansion and Contraction Joints

NOTES: Refer to ACI 224.3R for guidance on expansion joints.

The depth of contraction joints must be 1/4 to 1/3 of the thickness of the slab.

The maximum spacing (in mm) between adjacent joints must be 30 times the concrete thickness (in mm) for slabs exposed to the environment.

Make expansion and contraction joints in accordance with the details shown or as otherwise specified. Provide 13 mm thick transverse expansion joints where new work abuts an existing concrete. Cut contraction joints at a minimum of 25 mm deep with a jointing tool after the surface has been finished.

3.4 CURING AND PROTECTION

Cure and protect in accordance with ACI 301M, Section 5.

Beginning immediately after placement, and continuing for at least 7 days, cure and protect all concrete from premature drying, extremes in

temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. Provide all materials and equipment needed for adequate curing and protection at the site of the placement prior to the start of concrete placement. Accomplish moisture preservation of moisture for concrete surfaces not in contact with forms by one of the following methods:

- a. Continuous sprinkling or ponding.
- b. Application of absorptive mats or fabrics kept continuously wet.
- c. Application of sand kept continuously wet.
- d. Application of impervious sheet material conforming to [ASTM C171](#) or [KS F 4007](#).
- e. Application of membrane-forming curing compound conforming to [ASTM C309](#) or [KS F 2540](#), Type 1-D, on surfaces permanently exposed to view. Accomplish Type 2 on other surfaces in accordance with manufacturer's instructions.

Accomplish the preservation of moisture for concrete surfaces placed against wooden forms by keeping the forms continuously wet for 7 days. If forms are removed prior to end of the required curing period, use other curing methods for the balance of the curing period. Do not perform protection removal if the temperature of the air in contact with the concrete may drop more than [15 degrees C](#) within a 24 hour period

3.5 FORM WORK

Provide form work in accordance with [ACI 301M](#), Section 2 and Section 5.

Forms shall be true to line and grade, mortar-tight, and sufficiently rigid to prevent objectionable deformation under load. Form surfaces for permanently exposed faces shall be smooth, free from irregularities, dents, sags, or holes. Chamfer exposed joints and exposed edges. Arrange internal ties so that when the forms are removed, the form ties are not less than [50 mm](#) from concrete surfaces permanently exposed to view or exposed to water on the finished structure.

3.5.1 Removal of Forms

Remove forms in accordance with [ACI 301M](#), Section 2.

3.6 STEEL REINFORCING

Reinforcement must be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.6.1 Fabrication

Shop fabricate steel reinforcement in accordance with [ACI 318](#) and [ACI SP-66](#). Provide shop details and bending in accordance with [ACI 318](#) and [ACI SP-66](#).

3.6.2 Splicing

Perform splices in accordance with [ACI 318](#) and [ACI SP-66](#).

3.6.3 Supports

Secure reinforcement in place by the use of metal or concrete supports, spacers, or ties.

3.7 EMBEDDED ITEMS

Before placing concrete, take care to determine that all embedded items are firmly and securely fastened in place. Provide embedded items free of oil and other foreign matter, such as loose coatings of rust, paint and scale. Embedding of wood in concrete is permitted only when specifically authorized or directed.

3.8 CHEMICAL FLOOR HARDENER

NOTE: Clearly indicate slab surfaces requiring a chemical hardener. Such treatment is suitable for surfaces of concrete floors in equipment rooms and on other floor surfaces that are subject to light foot traffic only and will not be covered with resilient flooring, paint, or other finish coating.

Apply Chemical Floor Hardener where indicated, after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. First coat is one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow it to dry 24 hours before applying next coat. Apply proprietary chemical hardeners in accordance with manufacturer's printed directions.

3.9 TESTING AND INSPECTING

Report the results of all tests and inspections conducted at the project site informally at the end of each shift. Submit written reports weekly. Deliver within three days after the end of each weekly reporting period. See Section 01 45 00 QUALITY CONTROL.

3.9.1 Field Testing Technicians

The individuals who sample and test concrete must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.9.2 Preparations for Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement to certify that it is ready to receive concrete.

3.9.3 Sampling and Testing

- a. Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M or KS F 2401. Make six test cylinders.
- b. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 77 cubic meters of concrete. Test two

cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Conform test specimens to [ASTM C31/C31M](#) or [KS F 2403](#). Perform [compressive strength testing](#) conforming to [ASTM C39/C39M](#) or [KS F 2405](#).

- c. Test [slump](#) at the site of discharge for each design mix in accordance with [ASTM C143/C143M](#) or [KS F 2402](#). Check slump once during each shift that concrete is produced for each strength of concrete required.
- d. Test [air content](#) for air-entrained concrete in accordance with [ASTM C231/C231M](#) or [KS F 2421](#). Test concrete using lightweight or extremely porous aggregates in accordance with [ASTM C173/C173M](#) or [KS F 2449](#). Check air content at least once during each shift that concrete is placed for each strength of concrete required.
- e. Determine temperature of concrete at time of placement in accordance with [ASTM C1064/C1064M](#). Check concrete temperature at least once during each shift that concrete is placed for each strength of concrete required.

3.9.4 Action Required

3.9.4.1 Placing

Do not begin placement until the availability of an adequate number of acceptable vibrators, which are in working order and have competent operators, has been verified. Discontinue placing if any lift is inadequately consolidated.

3.9.4.2 Air Content

Whenever an air content test result is outside the specification limits, adjust the dosage of the air-entrainment admixture prior to delivery of concrete to forms.

3.9.4.3 Slump

Whenever a slump test result is outside the specification limits, adjust the batch weights of water and fine aggregate prior to delivery of concrete to the forms. Make the adjustments so that the water-cementitious material ratio does not exceed that specified in the submitted concrete mixture proportion and the required concrete strength is still met.

-- End of Section --