

PROJECT TABLE OF CONTENTS

DIVISION 1 - GENERAL REQUIREMENTS

01090 SOURCES FOR REFERENCE PUBLICATIONS

DIVISION 2 - SITE WORK

02315 EXCAVATION, DEMOLITION, FILLING AND BACKFILLING

DIVISION 3 - CONCRETE

03150 EXPANSION JOINTS

03200 CONCRETE REINFORCEMENT

03300 CAST-IN-PLACE STRUCTURAL CONCRETE

SECTION TABLE OF CONTENTS
DIVISION 01 - GENERAL REQUIREMENTS
SECTION 01090
SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 ORDERING INFORMATION

-- End of Section Table of Contents --

SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the sponsoring organization, e.g.

ASTM B 564 Nickel Alloy Forgings. However, when the sponsoring organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the organizations whose publications are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the sponsoring organization should be ordered from the source by title rather than by number.

ACI INTERNATIONAL (ACI)

P.O. Box 9094
Farmington Hills, MI 48333-9094
Ph: 248-848-3700
Fax: 248-848-3801
Internet: <http://www.aci-int.org>
AOK6/99

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
Internet: www.astm.org
NOTE: The annual ASTM Book of Standards (66 Vol) is available for \$3500.00. Prices of individual standards vary.
AOK6/99

AMERICAN WELDING SOCIETY (AWS)

550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353
Fax: 305-443-7559
Internet: <http://www.amweld.org>
AOK6/99

CORPS OF ENGINEERS (COE)

Order from:

U.S. Army Engineer Waterways Experiment Station
ATTN: Technical Report Distribution Section, Services
Branch, TIC
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199
Ph: 601-634-2571
Fax: 601-634-2506

NOTE: COE Handbook for Concrete and Cement (Documents w/prefix
CRD-C) (1949-present; 2 Vol) free to Government offices; \$10.00
plus \$8.00 per yr for 4 qtrly supplements to others). Individual
documents, single copies free. Order from address above.
AOK6/99

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Department of Commerce
Gaithersburg, MD 20899-0001
Ph: 301-975-4025
Fax: 301-926-1630
Order Publications From:
Superintendent of Documents
U.S. Government Printing Office (GPO)
Washington, DC 20402
Ph: 202-512-1800
Fax: 202-512-2250

or

National Technical Information Services (NTIS)
5285 Port Royal Rd.
Springfield, VA 22161
Ph: 800-553-6847
Fax: 703-321-8547
Internet: <http://www.gov/ntis.gov>
AOK6/99

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

900 Spring St.
Silver Spring, MD 20910
Ph: 301-587-1400
Fax: 301-585-4219
AOK6/99

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02315

EXCAVATION, DEMOLITON, FILLING AND BACKFILLING

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEGREE OF COMPACTION
- 1.3 SUBMITTALS

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 Satisfactory Materials
 - 2.1.2 Unsatisfactory Materials
 - 2.1.3 Cohesionless and Cohesive Materials

PART 3 EXECUTION

- 3.1 DEMOLITION
- 3.2 EXCAVATION
- 3.3 DRAINAGE AND DEWATERING
 - 3.3.1 Drainage
- 3.4 CLASSIFICATION OF EXCAVATION
- 3.5 UTILITY AND DRAIN TRENCHES
- 3.6 EXCAVATED MATERIALS
- 3.7 SUBGRADE PREPARATION
- 3.8 FILLING AND BACKFILLING
- 3.9 TESTING
 - 3.9.1 In-Place Densities
 - 3.9.1.1 In-Place Density of Subgrades
 - 3.9.1.2 In-Place Density of Fills and Backfills
- 3.10 GRADING
- 3.11 PROTECTION

-- End of Section Table of Contents --

SECTION 02315

EXCAVATION, DEMOLITION, FILLING AND BACKFILLING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICES

AASHTO T 180 (1997) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33 (1999a) Concrete Aggregates

ASTM C 117 (1995) Material Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregate by Washing

ASTM C 136 (1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM D 422 (1963; R 1998) Particle-Size Analysis of Soils

ASTM D 1556 (1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 1557 (1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))

ASTM D 2487 (1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D 2922 (1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D 2937 (1994) Density of Soil in Place by the Drive-Cylinder Method

ASTM D 3017 (1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 4253	(2000) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557-91, Method C, for material that has no more than 30 percent retained on the 3/4 inch sieve and has more than 20 percent retained on the 3/8 inch sieve. Where the material does not meet these gradation requirements, AASHTO T 180 method D will be used. Where free draining soils, i.e., sand or gap-graded aggregate are to be compacted, use ASTM D 4253. The procedure will be abbreviated below as a percentage of laboratory density.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Testing; FIO.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Gravel fill consisting of imported crusher waste or base course conforming to State of Hawaii Standard Specifications for Road and Bridge Construction, 1994, 1-1/2 inches maximum size. Gravel fill shall consist of clean, crushed, nonporous rock or crushed gravel. The maximum size shall be 1-1/2 inches and no more than 2 percent by weight shall pass through the No. 4 size sieve. Sand fill shall conform to ASTM C 33 No. 10 to No. 100.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, and stones larger than 2 inches. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC,

ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are nonplastic. Testing required for classifying materials shall be in accordance with ASTM C 117, ASTM C 136, ASTM D 422 and ASTM D 4318 as applicable.

PART 3 EXECUTION

3.1 DEMOLITION

Concrete slab shall be demolished to limits as required for new work. The Contractor shall take necessary precautions to prevent damage to adjacent walls, foundation and improvements which are to remain.

3.2 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each structure, and footing except as specified, and shall include trenching for utility and foundation drainage systems. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed and replaced with satisfactory material; and payment will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced, at no additional cost to the Government, with satisfactory materials to the indicated excavation grade; except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and over-break in rock excavation. Satisfactory material shall be placed and compacted as specified in paragraph FILLING AND BACKFILLING. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

3.3 DRAINAGE AND DEWATERING

3.3.1 Drainage

Surface water shall be directed away from excavation and construction sites to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.4 CLASSIFICATION OF EXCAVATION

Excavation will be unclassified regardless of the nature of material encountered.

3.5 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to

accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe, and the overdepth shall be backfilled with satisfactory material placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

3.6 EXCAVATED MATERIALS

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as determined by the Contracting Officer.

3.7 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

3.8 FILLING AND BACKFILLING

Satisfactory materials shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. Satisfactory materials shall be placed in horizontal layers not exceeding 8 inches in loose thickness, or 6 inches when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary to a moisture content at least 3 percent above optimum, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Backfill shall not be placed in wet areas. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around

pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Each layer of fill and backfill shall be compacted to not less than 95 percent of maximum density, ASTM D 1557.

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompaction over underground utilities and heating lines shall be by hand tamping.

3.9 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Field in-place density shall be determined in accordance with ASTM D 1556, or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937 shall be used only for soft, fine-grained, cohesive soils. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

Copies of Calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests.

3.9.1 In-Place Densities

In-place density and moisture content test results shall be included with the Contractor's daily construction quality control reports.

3.9.1.1 In-Place Density of Subgrades

One test per 1000 square foot or fraction thereof.

3.9.1.2 In-Place Density of Fills and Backfills

One test per 1000 square foot or fraction thereof of each lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of fill or backfill materials for trenches, pits, which are compacted with hand or hand-operated machines shall be tested as follows: One test per each area less than 20 square feet, or one test for each 10 linear foot of long narrow fills 10 feet or more in length. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows: One check for every (10) nuclear tests, or fraction thereof.

3.10 GRADING

Areas within 5 feet outside of each structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

3.11 PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work, shall be repaired and grades reestablished to the required elevations and slopes.

Excavation surfaces or finish subgrades shall be protected from drying out and cracking by keeping the surface continuously moist until concrete pours or placement of base course and vapor barrier. If excavation surfaces become wet or muddy the surface shall be dried and recompactd or the wet material removed.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03150

EXPANSION JOINTS

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS

PART 2 PRODUCTS

- 2.1 PREFORMED EXPANSION JOINT FILLER
- 2.2 Sikadur Combiflex Expansion Joint Sealing System
 - 2.2.1 Expansion Joints Sealing System
 - 2.2.2 Substitutions
 - 2.2.3 Sikadur Combiflex Expansion Joint Sealing System
 - 2.2.3.1 Epoxy Compressive Properties
 - 2.2.3.2 Epoxy Tensile Properties
 - 2.2.3.3 Epoxy Flexural Properties
 - 2.2.4 Epoxy Shear Strength
 - 2.2.5 Total Water Absorption
 - 2.2.5.1 Epoxy Bond Strength
 - 2.2.5.2 Epoxy Deflection Temperature
 - 2.2.5.3 Hypalon Sheeting Properties
 - 2.2.5.4 Cured System
 - 2.2.5.5 Cured System
 - 2.2.5.6 General Performance Criteria for Sikadur Combiflex Expansion Joint Sealing System (or approved equal)
 - 2.2.6 Substitutions
 - 2.2.7 Adeka MC-2010 MN Hydrophilic Waterstop
 - 2.2.8 Adeka P-201 Hydrophilic Waterstop
 - 2.2.9 Preformed Joint Filler Strips and Backer Rods
 - 2.2.10 Miscellaneous Sealant Materials

PART 3 EXECUTION

- 3.1 Sikadur Combiflex Expansion Joint Sealing System
 - 3.1.1 Combiflex Qualifications of Installers
 - 3.1.2 Combiflex Installation Preparation
 - 3.1.3 Combiflex Installation Procedure
- 3.2 ADEKA WATERSTOP (OR EQUAL)
 - 3.2.1 Adeka Waterstop (or equal) Qualification of Installation
 - 3.2.2 Adeka Waterstop Installation Preparation
 - 3.2.3 Adeka Installation Procedure
- 3.3 Warranty

-- End of Section Table of Contents --

SECTION 03150
EXPANSION JOINTS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 881	(1991) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 882	(1999) Bond-Strength of Epoxy-Resin Systems Used with Concrete Slant Shear
ASTM D 412	(1997) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 570	(1998) Water Absorption of Plastics
ASTM D 624	(2000) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 638	(1999) Tensile Properties of Plastics
ASTM D 648	(2000; Rev A) Deflection Temperature of Plastics under Flexural Load in the Edgewise Position
ASTM D 695	(1996) Compressive Properties of Rigid Plastics
ASTM D 732	(1999) Shear Strength of Plastics by Push Tool
ASTM D 790	(2000) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Material
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996e1) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 2240	Rubber Property - Durometer Hardness
ASTM D 5249	(1995) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Expansion Joint Sealant; GA.

Manufacturer's literature, including safety data sheets.

SD-04 Drawings

Expansion Joint Sealant; FIO.

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

SD-06 Instructions

Expansion Joint Sealant; FIO.

Manufacturer's recommended instructions for installing expansion joint sealant.

Contractor shall submit installation instructions for the Sikadur Combiflex Expansion joint Sealing System (or approved equal). Installation shall include conditions that will prevent installation of the Expansion Joint Sealing System including maximum temperatures, maximum moisture content of substrate and other factors. Installation procedures shall also include method of testing and repair of construction defects.

SD-13 Certificates

Certification from the Sikadur Combiflex Expansion Joint Sealing System (or approved equal) manufacturer demonstrating compliance to requirements specified including but not limited to the following:

- a. ISO 9000 quality standard in the development, manufacture, and sale of the product.
- b. NSF approval.
- c. Large joint movements of 25%.
- d. ASTM test results.
- e. History of use in potable water structures for the past 20 years.
- f. Factory approved training certification of installers.
- g. List of 5 previous projects by installers.
- h. Certificate of warranty.

SD-14 Samples

Expansion Joint Sealant; FIO.

PART 2 PRODUCTS

2.1 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

2.2 Sikadur Combiflex Expansion Joint Sealing System

Sikadur Combiflex Expansion Joint Sealing system or approved equal.

2.2.1 Expansion Joints Sealing System

Expansion Joints Sealing System, shall consist of the Sikadur Combiflex Expansion Joint Sealing System as manufactured by Sika Corporation, Lynhurst, New Jersey, or a product equal in performance to the Sikadur Combiflex Expansion Joint Sealing System.

2.2.2 Substitutions

The use of other than the Sikadur Combiflex Expansion Joint Sealing System will be considered providing the contractor requests its use in writing to the Contracting Officer. This request shall be accompanied by (a) A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds the following specific performance criteria, tested in accordance with the specified test standards; and (b) documented proof that the proposed substitute system, has a five year proven record of performance of joint and crack sealing, confirmed by actual field tests and five successful installations that the Contracting Officer can investigate.

2.2.3 Sikadur Combiflex Expansion Joint Sealing System

Sikadur Combiflex Expansion Joint Sealing System (or equivalent)
Performance Criteria.

2.2.3.1 Epoxy Compressive Properties

Epoxy Compressive Properties (ASTM D 695) at 28 days.

- a. Compressive Strength: 10,000 psi mm.
- b. Modulus of Elasticity: 7.0×10^5 psi min.

2.2.3.2 Epoxy Tensile Properties

Epoxy Tensile Properties (ASTM D 638) at 14 days.

- a. Tensile Strength: 300 psi min.
- b. Elongation at Break: 0.3% min.
- c. Modulus of Elasticity: 5.3×10^5 psi min.

2.2.3.3 Epoxy Flexural Properties

Epoxy Flexural Properties (ASTM D 790) at 14 days.

- a. Flexural Strength (Modulus of Rupture): 3700 psi min.
- b. Tangent Modulus of Elasticity in B ending: 8.5×10^5 psi min.

2.2.4 Epoxy Shear Strength

Epoxy Shear Strength (ASTM D 732) at 14 days: 2800 psi min.

2.2.5 Total Water Absorption

Total Water Absorption (ASTM D 570) at 7 days: 1.0% max. (2 hour boil).

2.2.5.1 Epoxy Bond Strength

Epoxy Bond Strength (ASTM C 882) Hardened Concrete to Hardened Concrete.

- a. 2 day (dry cure): 2800 psi min.
- b. 14 day (moist cure): 2000 psi min.

2.2.5.2 Epoxy Deflection Temperature

Epoxy Deflection Temperature (ASTM D 648) at 14 days: 104 Degrees F min. (fiber stress loading=264 psi).

2.2.5.3 Hypalon Sheeting Properties

Hypalon sheeting properties shall conform to:

- a. Tensile Properties (ASTM D 412).
- b. Tensile Strength 1150 psi max.
- c. Tensile Stress at 100% elongation: 475 psi max
- d. Ultimate Elongation at rupture: 700% min.
- e. Tear Resistance (ASTM D 624): 200 psi min.

2.2.5.4 Cured System

Cured System shall be ultraviolet resistant.

2.2.5.5 Cured System

Cured system shall be resistant to ozone/air (up to 300 ppm) and ozone/water up to 3 ppm.

The cured system shall be capable of tolerating face and back pressure.

2.2.5.6 General Performance Criteria for Sikadur Combiflex Expansion Joint Sealing System (or approved equal)

Approved for use in potable water contact by NSF.

The epoxy resin adhesive shall conform to ASTM C 881 and AASHTO M 235-90.

Acceptable for use in temperature of 128 degrees F continuous and 150 degrees F intermittent.

Acceptable for use in contact with chlorinated water up to 30 ppm continuous and 200 ppm one hour.

Acceptable for use with exposure to salt water in water or concrete.

ISO 9000 quality standard in the development, manufacture, and sale of the product.

Capable of withstanding large expansion joint movement of 3/8 inches.

Satisfactory application in potable water structures for the past 20 years

2.2.6 Substitutions

The use of other than the Adeka MC-2010 MN and P201 Hydrophilic Waterstop will be considered providing the contractor requests its use in writing to the Contracting Officer. This request shall be accompanied by (a) A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds the following specific performance criteria, tested in accordance with the specified test standards; and (b) Documented proof that the proposed substitute system has a five year proven record of performance of joint and crack sealing, confirmed by actual field tests and five successful installations that the Contracting Officer can investigate.

2.2.7 Adeka MC-2010 MN Hydrophilic Waterstop

Adeka MC-2010 MN Hydrophilic Waterstop (or approved equal) Performance Criteria.

- a. Surface applied waterstop (non embedded rubber waterstop)
- b. Hardness 20 + - 6 (ASTM D 2240)
- c. Tensile Strength 100 psi (ASTM D 412)
- d. Elongation (%) 500% (ASTM D 412)
- e. Safe for potable water contact (NSF approved).

Acceptable for contact with salt water, chlorinated water (30 ppm)

Acceptable for use for temperatures up to 150 degrees (4 hours duration)

2.2.8 Adeka P-201 Hydrophilic Waterstop

Adeka P-201 Hydrophilic Waterstop (or approved equal) Performance Criteria

- a. Surface applied waterstop (non embedded rubber waterstop)
- b. Hardness 20 + - 6 (ASTM D 2240)
- c. Tensile Strength 350 psi (ASTM D 412)

- d. Elongation (%) 700% (ASTM D 412)
- e. Safe for potable water contact. (NSF approved)
- f. Acceptable for contact with salt water, chlorinated water (30 ppm)
- g. Acceptable for use for temperatures up to 150 degrees (4 hours duration)

2.2.9 Preformed Joint Filler Strips and Backer Rods

Preformed joint filler strip and backer rods shall be polyurethane foam acceptable for application in temperatures up to 175 degrees F.

2.2.10 Miscellaneous Sealant Materials

All miscellaneous materials including bond-breaker, primers and materials not listed but required by manufactures for installation of waterstops and sealing systems shall be provided under this contract.

PART 3 EXECUTION

3.1 Sikadur Combiflex Expansion Joint Sealing System

Sikadur Combiflex Expansion Joint Sealing System (or equal) Installation Procedure:

3.1.1 Combiflex Qualifications of Installers

Installers of Sikadur Combiflex Expansion Joint Sealing System (or equal) shall be certified by the factory as having had approved factory training and having installed at least combiflex sealing system in at least 5 previous projects.

3.1.2 Combiflex Installation Preparation

Installers shall verify conditions prior to actual installations of the Combiflex Expansion Joint Sealing System (or equal). Installers shall provide installation instruction to the government prior to actual installations. Installations procedures shall include conditions that will prevent installation of the Expansion Joint Sealing System including maximum temperatures, maximum moisture content of substrate and other factors. Installations procedures shall also include method of testing and repair of construction defects for the Sikadur Combiflex Expansion Joint Sealing System (or equal).

3.1.3 Combiflex Installation Procedure

Installers shall install Sikadur Combiflex Expansion Joint Sealing System (or equal) in accordance with manufacturer's recommendations. The contractor shall provide all materials, equipment, labor, inspection and testing necessary to install the Sikadur Combiflex Expansion Sealing System.

3.2 ADEKA WATERSTOP (OR EQUAL)

3.2.1 Adeka Waterstop (or equal) Qualification of Installation

Installers of Adeka Waterstop (or equal) shall be certified by the factory as having had approved factory training.

3.2.2 Adeka Waterstop Installation Preparation

Installers shall verify conditions prior to actual installation of the Adeka Waterstop (or equal). Installers shall provide installation instruction to the government prior to actual installations. Installation procedures shall include conditions that will prevent installation of the Adeka Waterstop (or equal) including maximum temperatures, maximum moisture content of substrate and other factors. Installation procedures shall also include method of testing and repair of construction defects for Adeka Waterstops (or equal).

3.2.3 Adeka Installation Procedure

Installers shall install Adeka Waterstop (or equal) in accordance with manufacturer's recommendations. The contractor shall provide all materials, equipment, labor, inspection and testing necessary to install Adeka Waterstop (or equal).

3.3 Warranty

All sealants and systems, including the Sikadur Combliflex Expansion Joint Sealing System (or equal), Sikaflex 2C and Adeka Waterstop shall be warranted for product defects and workmanship for a period of 3 years. The contractor shall provide all materials, labor and testing to repair damages within the 3 year warranty period.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 WELDING
- 1.4 DELIVERY AND STORAGE

PART 2 PRODUCTS

- 2.1 REINFORCING STEEL
- 2.2 WIRE TIES
- 2.3 SUPPORTS
- 2.4 SYNTHETIC FIBER REINFORCEMENT

PART 3 EXECUTION

- 3.1 REINFORCEMENT
 - 3.1.1 Placement
 - 3.1.2 Splicing
- 3.2 SYNTHETIC FIBER REINFORCED CONCRETE

-- End of Section Table of Contents --

SECTION 03200
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 318/318R (1999) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615/A 615M (1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 706/A 706M (1998) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM C 1116 (1995) Fiber-Reinforced Concrete and Shotcrete

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4 (1998) Structural Welding Code - Reinforcing Steel

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Concrete Reinforcement System; FIO.

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-08 Statements

Welding; FIO.

A list of qualified welders names.

SD-13 Certificates

Reinforcing Steel; FIO.

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

1.3 WELDING

Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.

1.4 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 REINFORCING STEEL

Reinforcing steel shall be epoxy coated deformed bars conforming to ASTM A 615/A 615M or ASTM A 706/A 706M, grades and sizes as indicated. Epoxy coating for reinforcing steel shall conform to ASTM A 934.

2.2 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.3 SUPPORTS

Specifically designed supports fabricated of plastic.

2.4 SYNTHETIC FIBER REINFORCEMENT

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inches or approved equal.

PART 3 EXECUTION

3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other

deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 SYNTHETIC FIBER REINFORCED CONCRETE

Fiber reinforcement shall be added to the concrete mix in accordance with the applicable sections of ASTM C 1116 and the recommendations of the manufacturer.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 LUMP SUM CONTRACT
- 1.3 SUBMITTALS
- 1.4 QUALIFICATIONS
- 1.5 FIELD TEST FLOOR SLAB
 - 1.5.1 Test Floor Slab
- 1.6 SPECIAL REQUIREMENTS
- 1.7 GENERAL REQUIREMENTS
 - 1.7.1 Tolerances
 - 1.7.1.1 Floors
 - 1.7.1.2 Floors by the Straightedge System
 - 1.7.2 Strength Requirements and w/c Ratio
 - 1.7.2.1 Strength Requirements
 - 1.7.2.2 Water-Cement Ratio
 - 1.7.3 Air Entrainment
 - 1.7.4 Slump
 - 1.7.5 Concrete Temperature
 - 1.7.6 Size of Coarse Aggregate
 - 1.7.7 Special Properties and Products
 - 1.7.8 Technical Service for Specialized Concrete
- 1.8 MIXTURE PROPORTIONS
 - 1.8.1 Proportioning Studies for Normal Weight Concrete
 - 1.8.2 Average Compressive Strength Required for Mixtures
 - 1.8.2.1 Computations from Test Records
 - 1.8.2.2 Computations without Previous Test Records
- 1.9 STORAGE OF MATERIALS
- 1.10 GOVERNMENT ASSURANCE INSPECTION AND TESTING
 - 1.10.1 Materials
 - 1.10.2 Fresh Concrete
 - 1.10.3 Hardened Concrete
 - 1.10.4 Inspection

PART 2 PRODUCTS

- 2.1 CEMENTITIOUS MATERIALS
 - 2.1.1 Portland Cement
- 2.2 AGGREGATES
 - 2.2.1 Fine Aggregate
 - 2.2.2 Coarse Aggregate
- 2.3 CHEMICAL ADMIXTURES
 - 2.3.1 Air-Entraining Admixture
 - 2.3.2 Water-Reducing or Retarding Admixture
 - 2.3.3 High-Range Water Reducer (HRWR)
 - 2.3.4 Evaporation Retarder

- 2.3.5 Expanding Admixture
- 2.4 CURING MATERIALS
 - 2.4.1 Impervious-Sheet
 - 2.4.2 Membrane-Forming Compound
 - 2.4.3 Burlap and Cotton Mat
- 2.5 WATER
- 2.6 NONSHRINK GROUT
- 2.7 LATEX BONDING AGENT
- 2.8 EPOXY RESIN
- 2.9 VAPOR BARRIER
- 2.10 JOINT MATERIALS
 - 2.10.1 Joint Fillers, Sealers, and Waterstops
- 2.11 SYNTHETIC FIBERS FOR REINFORCING
- 2.12 Evaporative Retarder

PART 3 EXECUTION

- 3.1 PREPARATION FOR PLACING
 - 3.1.1 Foundations
 - 3.1.1.1 Concrete on Earth Foundations
 - 3.1.2 Preparation of Previously Placed Concrete
- 3.2 CONCRETE PRODUCTION
 - 3.2.1 Portable, Batching, Mixing, and Transporting Concrete
 - 3.2.1.1 General
 - 3.2.1.2 Batching Equipment
 - 3.2.1.3 Scales
 - 3.2.1.4 Portable Batching Tolerances
 - 3.2.1.5 Moisture Control
 - 3.2.1.6 Concrete Mixers
 - 3.2.1.7 Stationary Mixers
- 3.3 CONCRETE PRODUCTION, SMALL PROJECTS
- 3.4 FIBER REINFORCED CONCRETE
- 3.5 TRANSPORTING CONCRETE TO PROJECT SITE
- 3.6 CONVEYING CONCRETE ON SITE
 - 3.6.1 Buckets
 - 3.6.2 Transfer Hoppers
 - 3.6.3 Chutes
 - 3.6.4 Belt Conveyors
 - 3.6.5 Concrete Pumps
- 3.7 PLACING CONCRETE
 - 3.7.1 Depositing Concrete
 - 3.7.2 Consolidation
 - 3.7.3 Hot Weather Requirements
 - 3.7.4 Prevention of Plastic Shrinkage Cracking
- 3.8 JOINTS
 - 3.8.1 Construction Joints
 - 3.8.2 Contraction Joints in Slabs on Grade
 - 3.8.3 Expansion Joints
 - 3.8.4 Dowels and Tie Bars
- 3.9 FINISHING FORMED SURFACES
 - 3.9.1 Class B Finish
 - 3.9.2 Smooth Finish
- 3.10 REPAIRS
 - 3.10.1 Damp-Pack Mortar Repair
 - 3.10.2 Repair of Major Defects
 - 3.10.2.1 Surface Application of Mortar Repair
 - 3.10.2.2 Repair of Deep and Large Defects
- 3.11 FINISHING UNFORMED SURFACES
 - 3.11.1 General

- 3.11.2 Rough Slab Finish
- 3.11.3 Floated Finish
- 3.11.4 Troweled Finish
- 3.12 CURING AND PROTECTION
 - 3.12.1 General
 - 3.12.2 Immersion Curing
- 3.13 SETTING BASE PLATES AND BEARING PLATES
 - 3.13.1 Nonshrink Grout
 - 3.13.1.1 Mixing and Placing of Nonshrink Grout
 - 3.13.1.2 Treatment of Exposed Surfaces
- 3.14 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL
 - 3.14.1 Grading and Corrective Action
 - 3.14.1.1 Fine Aggregate
 - 3.14.1.2 Coarse Aggregate
 - 3.14.2 Quality of Aggregates
 - 3.14.3 Scales, Batching and Recording
 - 3.14.4 Batch-Plant Control
 - 3.14.5 Concrete Mixture
 - 3.14.6 Inspection Before Placing
 - 3.14.7 Placing
 - 3.14.8 Vibrators
 - 3.14.9 Curing Inspection
 - 3.14.10 Mixer Uniformity
 - 3.14.11 Reports

-- End of Section Table of Contents --

SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	(1996) Standard Specifications for Structural Concrete
ACI 305R	(1991) Hot Weather Concreting
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31/C 31M	(1998) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1999a) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1999) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94	(1999) Ready-Mixed Concrete
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 143	(1998) Slump of Hydraulic Cement Concrete
ASTM C 150	(1998a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 192/C 192M	(1998) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 494	(1999) Chemical Admixtures for Concrete
ASTM C 878	(1995, Rev A) Standard Test Method for Restrained Expansion of Shrinkage - Compressive Concrete
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1997) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C 940	(1998a) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 1017	(1998) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1999) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064/C 1064M	(1999) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1116	(1995) Fiber-Reinforced Concrete and Shotcrete
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 1745	(1997) Standard Specification for Plastic Water Vapor Retarders Used in Contract with Soil or Granular Fill under Concrete Slabs

CORPS OF ENGINEERS (COE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices
------------	--

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards
NRMCA TMMB 100	(1994) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.2 LUMP SUM CONTRACT

Under this type of contract concrete items will be paid for by lump sum and will not be measured. The work covered by these items consists of furnishing all concrete materials, reinforcement, miscellaneous embedded materials, and equipment, and performing all labor for the forming, manufacture, transporting, placing, finishing, curing, and protection of concrete in these structures.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Mixture Proportions; GA.

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities

indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Testing and Inspection for Contractor Quality Control; GA.

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

SD-13 Certificates

Qualifications; GA.

Written documentation for Contractor Quality Control personnel.

SD-14 Samples

Surface Retarder; FIO.

Surface retarder material with manufacturer's instructions for application in conjunction with air-water cutting.

1.4 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades or shall have written evidence of having completed similar qualification programs:

Concrete Field Testing Technician, Grade I
 Concrete Laboratory Testing Technician, Grade I or II
 Concrete Construction Inspector, Level II

Concrete Transportation Construction Inspector or Reinforced Concrete Special Inspector, Jointly certified by American Concrete Institute (ACI), Building Official and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

1.5 FIELD TEST FLOOR SLAB

Field test slabs shall be constructed 3 months prior to beginning of work using the materials and procedures proposed for use on the job, to demonstrate the results to be attained. The quality and appearance of the test slab shall be subject to the approval of the Contracting Officer, and, if not judged satisfactory, additional test slabs shall be constructed until approval is attained. Formed or finished surfaces in the completed structure shall match the quality and appearance of the approved field example.

1.5.1 Test Floor Slab

The test floor slab shall be at least 4 feet by 5 feet and 6 inches thick. A full length expansion joint shall be constructed at the center of the test floor slab. All materials used for the actual expansion joint shall be used in the test floor slab. The concrete used for the test floor slab shall contain all admixtures used for the actual concrete. The test floor slab can be constructed in Honolulu or in Kwajalein and shall be available to the Contracting Officer for inspection.

1.6 SPECIAL REQUIREMENTS

A pre-installation meeting with the Contracting Officer will be required at least 10 days prior to start of construction. The Contractor shall be responsible for calling the meeting; the Project Superintendent and active installation personnel shall be present.

1.7 GENERAL REQUIREMENTS

1.7.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal.

1.7.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/117R and this Section shall apply:

Floor Profile Quality Classification From ACI 117/117R	This Section
-----	-----
Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish
Very Flat	Same. Use only with F-system

Levelness tolerance shall apply where design requires floors to be sloped to drains or sloped for other reasons.

1.7.1.2 Floors by the Straightedge System

The flatness of the floors shall be carefully controlled and the tolerances shall be measured by the straightedge system as specified in paragraph 4.5.7 of ACI 117/117R, using a 5 foot and adjusted for slopes to drain, straightedge and adjusted for slopes to drain, within 72 hours after floor slab installation and before shores and/or forms are removed. The listed tolerances shall be met at any and every location at which the straightedge can be placed.

Bullfloated	1/2 inches
Straightedged	5/16 inches
Float Finish	1/4 inches
Trowel Finish	3/16 inches

1.7.2 Strength Requirements and w/c Ratio

1.7.2.1 Strength Requirements

Specified compressive strength (f'c) shall be as follows:

COMPRESSIVE STRENGTH	STRUCTURE OR PORTION OF STRUCTURE
4000 psi at 28 days	All

Compressive strength shall be determined in accordance with ASTM C 39.

- a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (6 by 12 inch cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.
- b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.
- c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be

approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

1.7.2.2 Water-Cement Ratio

Maximum water-cement ratio (w/c) for normal weight concrete shall be as follows:

WATER-CEMENT RATIO, BY WEIGHT	STRUCTURE OR PORTION OF STRUCTURE
0.45	All

These w/c's may cause higher strengths than that required above for compressive or flexural strength. The maximum w/c required will be the equivalent w/c as determined by conversion from the weight ratio of water to cement plus pozzolan, by the weight equivalency method as described in ACI 211.1.

1.7.3 Air Entrainment

Air Entrainment shall be required.

1.7.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143.

Structural Element	Slump	
_____	Minimum	Maximum
Foundation walls, substructure walls, footings, slabs	5 in.	6 in.

When use of a plasticizing admixture conforming to ASTM C 1017 or when a Type F or G high range water reducing admixture conforming to ASTM C 494 is permitted to increase the slump of concrete, concrete shall have a slump of 2 to 4 inches before the admixture is added and a maximum slump of 8 inches at the point of delivery after the admixture is added.

1.7.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 90 degrees F. Concrete for the main water tank floor shall be placed at night between the hours of 08:00 pm and 06:00 AM.

1.7.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, 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.

1.7.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies. Admixture manufacturer shall provide written document showing compatibility of all materials.

1.7.8 Technical Service for Specialized Concrete

The services of a factory trained technical representative shall be obtained to oversee proportioning, batching, mixing, placing, consolidating, and finishing of concrete with HWWR admixture. A factory trained technical representative shall be present on site for the High-Range Water Reducer (HRWR) admixture. The technical representative shall be on the job full time until the Contracting Officer is satisfied that field controls indicate concrete of specified quality is furnished and that the Contractor's crews are capable of continued satisfactory work. The technical representative shall be available for consultation with, and advice to, Government forces.

1.8 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

1.8.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in subparagraph Water-Cement Ratio. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. 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/C 192M. They 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 set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

1.8.2 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength (f'_{cr}) exceeding the specified compressive strength (f'_c) by the amount indicated below. This required average compressive strength, f'_{cr} , will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below f'_{cr} during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day f'_{cr} , the mixture shall be adjusted, as approved, to bring the daily average back up to f'_{cr} . During production, the required f'_{cr} shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

1.8.2.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths (f'_c) within 1,000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength f'_{cr} used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'_{cr} = f'_c + 1.34S \text{ where units are in psi}$$

$$f'_{cr} = f'_c + 2.33S - 500 \text{ where units are in psi}$$

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

1.8.2.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength f'_{cr} shall be determined as follows:

- a. If the specified compressive strength f'_c is less than 3,000 psi,
 $f'_{cr} = f'_c + 1000$ psi
- b. If the specified compressive strength f'_c is 3,000 to 5,000 psi,
 $f'_{cr} = f'_c + 1,200$ psi
- c. If the specified compressive strength f'_c is over 5,000 psi,
 $f'_{cr} = f'_c + 1,400$ psi

1.9 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. 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. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. 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. 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 unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

1.10 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

1.10.1 Materials

The Government will sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

1.10.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

1.10.3 Hardened Concrete

Tests on hardened concrete will be performed by the Government when such tests are considered necessary.

1.10.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cementitious Materials shall be portland cement or portland-pozzolan and shall conform to appropriate specifications listed below.

2.1.1 Portland Cement

ASTM C 150, type II including false set requirements.

2.2 AGGREGATES

Aggregates shall conform to the following.

2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

2.2.2 Coarse Aggregate

Coarse aggregate shall conform to ASTM C 33, Class 5S, size designation 67.

2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

2.3.1 Air-Entraining Admixture

Air-Entraining Admixture shall not be used.

2.3.2 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

2.3.3 High-Range Water Reducer (HRWR)

Eucon 37, Euclid chemical company or approved equal IAW ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements are waived.

2.3.4 Evaporation Retarder

Eucobar , Euclid Chemical Company, or approved equal.

2.3.5 Expanding Admixture

Aluminum powder type expanding admixture conforming to ASTM C 937.

2.4 CURING MATERIALS

2.4.1 Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except, that polyethylene sheet shall not be used.

2.4.2 Membrane-Forming Compound

Membrane-Forming curing compound shall not be used.

2.4.3 Burlap and Cotton Mat

Burlap and cotton mat shall not be used.

2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107, and shall be a commercial formulation suitable for the proposed application.

2.7 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.8 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

2.9 VAPOR BARRIER

Vapor barrier material shall have the following properties:

Minimum 15-mil tick polyolefin geomembrane
Manufactured with ISO certified virgin resins.
Water Vapor Retarder ASTM E 1745 meets or exceeds Class B requirements with following modification;
Permeance Rating ASTM E 96 not exceeding 0.02 Perms

2.10 JOINT MATERIALS

2.10.1 Joint Fillers, Sealers, and Waterstops

Materials for expansion joints and waterstops shall be in accordance with Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS and joint sealants for expansion joints.

2.11 SYNTHETIC FIBERS FOR REINFORCING

Concrete shall contain synthetic fibers conforming to ASTM C 1116, Type III, Synthetic Fiber 7.5 lbs per cy. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 70 ksi graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.

2.12 Evaporative Retarder

Evaporative Retarder shall be sprayed over the fresh concrete surface immediately after bullfloating of the concrete floor slab. The evaporative retarder shall be Eucobar, by Euclid Chemical Company or approved equal. Spray equipment, mixing and application rate, installation shall be per manufacturers instructions. The evaporative retarder shall be used only to prevent rapid evaporation of the concrete slab moisture and shall not be used as a finishing aid.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from mastic. Forms shall be in place, cleaned, coated, and adequately supported. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1 Foundations

3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

3.1.2 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Apply epoxy bonding agent immediately prior to placing new concrete.

3.2 CONCRETE PRODUCTION

3.2.1 Portable, Batching, Mixing, and Transporting Concrete

All concrete shall be batched after sunset and before sunrise. Concrete shall either be batched and mixed onsite by on-site batch plant and transpoiled accordance with ASTM C 94. Concrete truck mixers shall not be used. Concrete shall be batched and mixed onsite, or close to onsite, and shall conform to the following subparagraphs.

3.2.1.1 General

The batching plant shall be located on site in the general area approved by the Contracting Officer. The batching, mixing and placing system shall have a capacity of at least 75 cubic yards per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

3.2.1.2 Batching Equipment

The batching controls shall be semiautomatic or automatic, as defined in NRMCA CPMB 100. A semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. The weight of water and admixtures shall be recorded if batched by weight. Separate bins or compartments shall be provided for each size group of aggregate and type of cementitious material, to prevent intermingling at any time. Aggregates shall be weighed either in separate weigh batchers with individual scales or, provided the smallest size is batched first, cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cementitious material. If both portland cement and other cementitious material are used, they may be batched cumulatively, provided that the portland cement is batched first, except that silica fume shall always be batched separately. Water may be measured by weight or volume. Water shall not be weighed or measured cumulatively with another ingredient. Filling and discharging valves for the water metering or batching system shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. Piping for water and for admixtures shall be free from leaks and shall be properly valved to prevent backflow or siphoning. Admixtures shall be furnished as a liquid of suitable concentration for easy control of dispensing. An adjustable, accurate, mechanical device for measuring and dispensing each admixture shall be provided. Each admixture dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and individually discharged automatically in a manner to obtain uniform distribution throughout the water as it is added to the batch in the specified mixing period. When use of truck mixers makes this requirement impractical, the admixture dispensers shall be interlocked with the sand batchers. Different admixtures shall not be combined prior to introduction in water and shall not be allowed to intermingle until in contact with the cement. Admixture dispensers shall have suitable devices to detect and indicate flow during dispensing or have a means for visual observation. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment, and for sampling and calibrating the dispensing of cementitious material, water, and admixtures. Filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.2.1.3 Scales

The weighing equipment shall conform to the applicable requirements of CPMB Concrete Plant Standard, and of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the specified frequency in the presence of a Government inspector. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

3.2.1.4 Portable Batching Tolerances

(A) Tolerances with Weighing Equipment

MATERIAL	PERCENT OF REQUIRED WEIGHT
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

(B) Tolerances with Volumetric Equipment

For volumetric batching equipment used for water and admixtures, the following tolerances shall apply to the required volume of material being batched:

MATERIAL	PERCENT OF REQUIRED MATERIAL
Water:	plus or minus 1 percent
Chemical admixtures:	0 to plus 6 percent

3.2.1.5 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched.

3.2.1.6 Concrete Mixers

Mixers shall be stationary mixers. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.2.1.7 Stationary Mixers

Concrete plant mixers shall be drum-type mixers of tilting, nontilting,

horizontal-shaft, or vertical-shaft type, or shall be pug mill type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94 applicable to central-mixed concrete.

3.3 CONCRETE PRODUCTION, SMALL PROJECTS

Batch-type equipment shall be used for producing concrete. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall be produced in accordance with ACI 301, and plant shall conform to NRMCA CPMB 100.

3.4 FIBER REINFORCED CONCRETE

Fiber reinforced concrete shall conform to ASTM C 1116 and as follows, using the fibers specified in PART 2. A minimum of 1.5 pounds of fibers per cubic yard of concrete shall be used. Fibers shall be added at the batch plant. Toughness indices shall meet requirements for performance level I of ASTM C 1116. The services of a qualified technical representative shall be provided to instruct the concrete supplier in proper batching and mixing of materials to be provided.

3.5 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in agitators, nonagitating transporting equipment conforming to NRMCA TMMB 100 or by approved pumping equipment or conveyors.

3.6 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

3.6.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yard shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.6.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically

operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.6.3 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.6.4 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper, for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches.

The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

3.6.5 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.7 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

3.7.1 Depositing Concrete

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. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

3.7.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches thick or less. 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 vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.025 inch, and the head diameter shall be appropriate for the structural member and the concrete mixture 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 reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segregation or flotation of coarse aggregate shall be prevented. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

3.7.3 Hot Weather Requirements

Concrete shall be placed at night. When the ambient temperature during concrete placing is expected to exceed 85 degrees F, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064/C 1064M. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	90 F
40-60	85 F
Less than 40	80 F

3.7.4 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.8 JOINTS

Joints shall be located and constructed only as indicated or approved.

3.8.1 Construction Joints

Construction joints are not permitted.

3.8.2 Contraction Joints in Slabs on Grade

There are no contraction joints for the tank slab.

3.8.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section 03150 EXPANSION JOINTS.

3.8.4 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1/8 inch in 12 inches. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely embeds the dowel or tie bar and is thoroughly consolidated.

3.9 FINISHING FORMED SURFACES

Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

3.9.1 Class B Finish

Class B finish is required to all formed concrete surfaces. Fins, ravelings, and loose material shall be removed, all surface defects over 1/2 inch in diameter or more than 1/2 inch deep, shall be repaired and, except as otherwise indicated. Defects more than 1/2 inch in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep.

The Contractor shall prepare a sample panel for approval (as specified in PART 1) before commencing repair, showing that the surface texture and color match will be attained.

3.9.2 Smooth Finish

After other concrete construction is complete in each overall separate contiguous area of the structure, smooth finish shall be applied to the areas indicated on the drawings. A mortar mix consisting of one part portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be used. Where the finished surface will not receive other applied surface, white cement shall be used to replace part of the job cement to produce an approved color, which shall be uniform throughout the surfaces of the structure. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads having on their surface the same sand-cement mix specified above but without any mixing water, until all of the visible grout film is removed. The burlap pads used for this operation shall be stretched tightly around a board to prevent dishing the mortar in the voids. The finish of any area shall be completed in the same day, and

the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours commencing immediately after finishing operations in each area. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas or at night, and shall never be applied when there is significant hot, dry wind.

3.10 REPAIRS

3.10.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 4 inches shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

3.10.2 Repair of Major Defects

Major defects will be considered to be those more than 1/2 inch deep or, for Class A and B finishes, more than 1/2 inch in diameter and, for Class C and D finishes, more than 2 inches in diameter. Also included are any defects of any kind whose depth is over 4 inches or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

3.10.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 2 inches on all sides. All such defective areas greater than 12 square inches shall be outlined by saw cuts at least 1 inch deep. Defective areas less than 12 square inches shall be outlined by a 1 inch deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar,

preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

3.10.2.2 Repair of Deep and Large Defects

Deep and large defects will be those that are more than 6 inches deep and also have an average diameter at the surface more than 18 inches or that are otherwise so identified by the Project Office. Such defects shall be repaired as specified herein or directed, except that defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced. Deep and large defects shall be repaired by procedures approved in advance including forming and placing special concrete using applied pressure during hardening. Preparation of the repair area shall be as specified for surface application of mortar. In addition, the top edge (surface) of the repair area shall be sloped at approximately 20 degrees from the horizontal, upward toward the side from which concrete will be placed. The special concrete shall be a concrete mixture with low water content and low slump, and shall be allowed to age 30 to 60 minutes before use. Concrete containing a specified expanding admixture may be used in lieu of the above mixture; the paste portion of such concrete mixture shall be designed to have an expansion between 2.0 and 4.0 percent when tested in accordance with ASTM C 940. A full width "chimney" shall be provided at the top of the form on the placing side to ensure filling to the top of the opening. A pressure cap shall be used on the concrete in the chimney with simultaneous tightening and revibrating the form during hardening to ensure a tight fit for the repair. The form shall be removed after 24 hours and immediately the chimney shall be carefully chipped away to avoid breaking concrete out of the repair; the surface of the repair concrete shall be dressed as required.

3.11 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

3.11.1 General

In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be

true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.11.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

3.11.3 Floated Finish

Slabs to receive more than a rough slab finish shall next be given a 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. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 1/4 inch and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Lightweight concrete or concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

3.11.4 Troweled Finish

All tank floor slabs shall be given a trowel finish. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, 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. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled 4 times, with waiting period between each. Care shall be taken to prevent blistering and

if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

3.12 CURING AND PROTECTION

3.12.1 General

Concrete shall be cured by total immersion of water 60 days after concrete finishing.

3.12.2 Immersion Curing

Concrete slab for sump pit area slab shall be used with impetuous sheeting and continuous mist spraying. The main concrete slab shall be cured by continuous immersed with 1 inches to 2 inches of potable water immediately after finishing the concrete slab for a period of 60 days.

3.13 SETTING BASE PLATES AND BEARING PLATES

3.13.1 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.13.1.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.13.1.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 1 inch and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a

smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

3.14 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations for conformance with ASTM C 1077.

3.14.1 Grading and Corrective Action

3.14.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.14.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

3.14.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In

addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.14.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.14.4 Batch-Plant Control

The measurement of concrete materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during each day's plant operation.

3.14.5 Concrete Mixture

- a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 878. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and

a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

- b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.
- c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 1/2 inch below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 inches. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods

cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

- d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.
- e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064/C 1064M. The temperature shall be reported along with the compressive strength data.
- f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 500 cubic yards or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39 for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.

3.14.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.14.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.14.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

3.14.9 Curing Inspection

- a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.
- b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.
- c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, shall compute the rate of coverage in square feet per gallon, and shall note whether or not coverage is uniform.
- d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.
- e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas

being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

- f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.14.10 Mixer Uniformity

- a. Stationary Mixers. Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.
- b. Truck Mixers. Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.
- c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.14.11 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --