



## Facilities Planning and Construction Design and Construction Standards

### **DIVISION 03 - Concrete**

#### **Preface**

The Texas Tech University System's 'Design and Construction Standards', as administrated by Facilities Planning and Construction, are intended to serve as guidelines to the Design Professional and Construction Management teams for design development and construction administration of Texas Tech University System (TTUS) Capital Projects. They communicate the minimum expectations and requirements relative to specific building systems, design provisions, general specification requirements, and administrative procedures for new facilities being constructed on Texas Tech University System (ASU, MSU, TTU, TTUHSC, and TTUHSC El Paso) campuses. Several, but not all requirements for each component Institution or Agency within the TTU System are covered. Design Professionals, Construction Managers at Risk and/or Design-Build Firms shall also refer to provisions covered in their service Agreements, as well as within the project's Basis of Design (BOD) document.

In addition, the 'Design and Construction Standards' shall also be utilized in conjunction with the approved project specific Program and Schematic Design development. In the event of conflict between this document and specific project requirements, Design Professionals, Construction Managers at Risk and/or Design-Build Firms shall contact Facilities Planning & Construction for clarification.

The guidelines within the 'Design and Construction Standards' are not intended to prohibit the use of alternative design solutions, methods, systems, products or devices not covered in this document. Offered alternatives deviating from or not covered in these standards shall be documented by the Design Professional and/or Construction Management teams and submitted to Facilities Planning & Construction for approval prior to implementation.

Throughout the 'Design and Construction Standards' there are references to manufacturer specific products. These are to be considered the 'Basis of Design' to establish the expected

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minimum quality requirements. Design Professionals are encouraged to identify and include equivalent products and/or manufacturers offering comparable products to facilitate open bidding environments.

**General Requirements for Concrete**

Concrete construction shall be designed, formed, placed, finished, and tested in strict accordance with the American Society for Testing and Materials (ASTM) and the American Concrete Institute's (ACI) requirements.

Concrete products and materials (mix designs, reinforcement, and strength requirements) will be specified by the Project Design Professionals. Pre-installation meetings are required prior to commencement of the Work to determine the acceptable working restrictions concerning water added at site, use of admixtures, transportation and delivery methods, conditional weather requirements, concrete curing, materials testing and inspections, etc.

Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities. Delivery tickets shall be furnished with each load of concrete delivered to the project. Ticket shall show class and strength of concrete, number of pounds of cementitious material, size of coarse aggregate, batching time, slump ordered and amount of admixture. Indicate amounts of mix water to be withheld for later addition at project site.

Batch design mixes will be specified by the Design Professional. Manufacturer's batching mixture and reinforcement certificate (when applicable) must be approved by the Design Professional prior to installation.

The Design Professional must specify that the Owner reserves the right to inspect the batching plant and the mixing processes. Admixtures may be added to the concrete design mix as per Design Professional's recommendation to improve strength, workability, or to meet project needs. Do not add water to concrete after adding high-range water-reducing admixtures to mix. Do not add water to concrete beyond the limit of water withheld from the plant.

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The Design Professional shall specify to protect freshly placed concrete from premature drying and excessive cold or hot temperatures. **Concrete slabs-on-grade, elevated concrete slabs and concrete roof decks associated with the building footprint are required to be quality controlled from excessive shrinkage cracking by active curing methods implementing wet curing blankets. The Design Professional is to specify the use of Sika UltraCure NCF, Sika UltraCure DOT, or a comparable wet cure blanket in PART 3: Execution portion of 03 33 00 Concrete specification.**

Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing. Minimum actual concrete temperature shall never be less than 50 degrees F from the truck at time of placement, and maximum concrete temperature shall never exceed 95 degrees F from the truck at time of placement. Contractor shall develop a cold weather concreting plan and a hot weather concrete plan prior to placement of any concrete.

Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement.

Acquire composite fresh concrete specimens for the purpose of strength confirmation shall be obtained and field cured according to ASTM C 31. Sampling of fresh concrete for slump, temperature and air content shall be performed in accordance with ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

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4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
6. Compression Test Specimens: ASTM C 39; cast, mold and cure one set of four standard 6"X12" test cylinder specimens or five 4"X8" test cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C 39; for 6"X12" cylinders test one cured specimens at 7 days for information only and two at 28 days to average compressive strength. Hold one sample for re-testing if required. For 4"X 8" cylinders test one cured specimens at 7 days for information only and three at 28 days to average compressive strength. Hold one sample for re-testing if required.
  - a. A compressive-strength test shall be the average of the strengths of at least two 6"X12" cylinders or at least three 4"X8" cylinders made from the same sample of concreted and tested at 28 days.
8. Testing specimens are to be taken after all admixtures and/or field added water has been added and incorporated into concrete.

**Fiber-Reinforced Concrete for Site Work (Types II, III and IV – 4,000psi)**  
*(Refer to Division 32 Exterior Improvements)*

Sidewalks and paved pathways for the purposes of pedestrian and light vehicle traffic.

Fiber-Reinforced Concrete shall be designed per ACI 544 Report on Fiber-Reinforced Concrete, ACI 544.3R "Guide for Specifying, Proportioning, and Production of Fiber-Reinforced Concrete", ACI 544.4R "Guide to Design with Fiber-Reinforced Concrete" and ACI 360R "Guide to the Design of Slabs-on-Ground".

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***NOTE: Where soils are not conducive for the use of Fiber-Reinforced Concrete, provide concrete for site work using wire mesh reinforcement.***

Fiber-Reinforced Concrete shall be specified, classified and tested in conformance with the following requirements:

- ASTM C 1116/C 1116M - Standard Specification for Fiber-Reinforced Concrete
- ASTM C 1399 - *Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete*
- ASTM C 1609/C 1609M - *Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete*
- ASTM C 94/ C 94M - *Specification for Ready-Mixed Concrete*
- ASTM C 685/C 685M - *Specification for Concrete Made by Volumetric Batching and Continuous Mixing*
- DMS-4550 – *Qualifications Fibers for Concrete* (Texas Department of Transportation)

Concrete fiber shall be 100% virgin monofilament or fibrillated polypropylene fibers specifically manufactured for use as concrete reinforcement and so certified by the manufacturer and containing no reprocessed olefin materials.

Fibrous concrete reinforcement shall be manufactured by:

1. The Euclid Chemical Co., 19218 Redwood Drive, Cleveland, Ohio
2. Fibermesh Company, 4019 Industry Drive, Chattanooga, Tennessee 37416
3. CorMix Construction Products, P. O. Box 190970, Dallas, Texas 75219
4. W. R. Grace Company, 6606 Marshall Boulevard, Lithonia, Georgia
5. Forta Corporation, 100 Forta Drive, Grove City, Pennsylvania 16127

The physical characteristics of the fiber:

1. Specific gravity - 0.91 g/cc

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2. Tensile strength - 70-110 ksi.
3. Fiber lengths - 1-1/2", 2" per manufacturer.

**03 30 00 Cast-In-Place Concrete**

**Concrete and Concrete Structures**

Concrete design for primary building structures is to comply with the requirements of ASCE 7, Minimum Design Loads for Buildings and Other Structures, ACI 318, Building Code Requirements for Structural Concrete, as well as other applicable building codes. ACI 318 includes the requirements for performance-based seismic design verification and construction of structural concrete structures necessary to ensure public health and safety.

Owner will enlist the services of a third-party design firm specializing in Structural Design to conduct peer reviews of the sealing Structural Engineer of Records design, inclusive of design calculations review.

Concrete reinforcing bars to be ASTM A 615, Grade 60, deformed.

1. Admixtures are to be certified by the manufacturer to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride. Air-Entraining Admixture: ASTM C 260 for exposed exterior concrete.
2. Water-Reducing Admixture: ASTM C 494, Type A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
5. Water-Reducing and Retarding Admixture: ASTM C 494, Type D. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

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6. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable free of carbon black, nonfading, and resistant to lime and other alkalis.

Vapor barrier shall conform to ASTM E 154 polyethylene sheet not less than 15 mils thick. Place, protect, and repair vapor-retarder sheets according to manufacturer's written instructions.

Floor Flatness (FF) and Levelness (FL) Tolerances for finish floors or subfloors shall be determined in accordance with ASTM E1155. The Design Professional shall specify the Flatness and Levelness tolerances to meet Project requirements.

Concrete finishes to be determined by the Design Professional and the Owner's Representative during the design phase.

### ***03 35 43 Polished Concrete Finishing***

The Design Professional, after confirmation by the Owner, will specify the classification of Aggregate Exposure and the Level of Reflective Clarity and Reflective Sheen.

The Design Professional will specify the concrete mix design for the portion of concrete that will be polished. Each mix ingredient should be from the same source, from the same respective batch, and each delivered to the concrete producer in one delivery.

Use a uniformly graded mix of not less than 3 aggregate sizes – fine, intermediate, and large.

Specify that the Installer must be experienced in performing work of this section and specialized in installation of work similar to that required for this project, with minimum three years documented experience. References will be made available upon request.

A 100 sq. ft mock-up sample panel will be required at the jobsite at a location as directed under conditions similar to those which will exist during actual placement. Mock-ups will be used to judge workmanship, concrete substrate preparation, operation of equipment, material application, color selection and shine. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Mockup location will be per Owner's Representative and Architect's directive.

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Floor polishing, sealing procedures and treatments to be per Design Professional and manufacturer's recommendations.

**03 41 00 Precast Structural Concrete | 03 45 00 Precast Architectural Concrete**

Architectural Precast Concrete is to comply with PCI Design Handbook and with applicable portions of ACI 301. In general, use white Portland Cement for exposed faces. Specify facing aggregate and finish. Reinforcement and anchors shall be galvanized or stainless steel. Embedded/recessed lifting eyes shall have epoxy or other approved coated rebar or steel.

Specify that a qualified manufacturer of precast concrete units similar to those indicated for this project that has sufficient production capacity to manufacture the required units. Precast units shall be obtained through a single source from a single manufacturer throughout the project. References will be made available upon request.

Specify that the Installer shall have a minimum of 5 years documented experience and is qualified for installing precast concrete stone to the level of this project. References will be made available upon request.

**03 49 00 Glass-Fiber-Reinforced Concrete (GFRC)**

Structural Performance: GFRC panels, including panel frames, anchors, and connections, shall withstand applicable design loads, as well as the effects of thermal and moisture induced volume changes, according to load factors and combinations established in PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panel."

Deflection Limits: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span. Design panel frames and connections to accommodate deflections and other building movements.



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**Qualification Data:** A qualified manufacturer that participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for Group G, Glass Fiber Reinforced Concrete.

Certification shall be maintained throughout the production of the glass-fiber-reinforced concrete units. Production shall immediately stop if at any time the fabricator's certification is revoked, regardless of the status of completion of contracted work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established. In the event certification(s) cannot be re-established in a timely manner, causing project delays, the fabricator, at no additional cost, will contract out the remainder of the units to be manufactured at a PCI certified plant.

**Mockups:** Build mockups to demonstrate aesthetic effects and establish the required quality acceptance standards for fabrication and installation of the project.

**GFRC Mix Material Standards:**

- Portland Cement: ASTM C150, Type I, II, or III.
- Metakaolin: ASTM C618, Class N.
- Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 to 2 inches long, specifically produced for use in GFRC, and complying with ASTM C1666/C1666M
- Sand for GFRC Backing: Washed and dried silica, complying with composition requirements of ASTM C144; passing No. 20 (0.85-mm) sieve with a maximum of 2 percent passing No. 100 (0.15-mm) sieve.
- Color Admixes: ASTM C979, synthetic mineral-oxide pigments or colored water reducing admixtures, temperature stable, nonfading, and alkali resistant.
- Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL 130.
- Polymer Curing Admixture: Acrylic thermoplastic copolymer dispersion complying with PCI MNL 130.
- Air-Entraining Admixture: ASTM C260, containing not more than 0.1 percent chloride ions.

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- Chemical Admixtures: ASTM C494/C494M, containing not more than 0.1 percent chloride ions.

Manufacturing Tolerances and Source Quality Control: As designed and/or at a minimum, comply with PCI MNL 130.