

# 1902 - QUALITY CONTROL PROGRAM FOR PRECAST CONCRETE PRODUCTS

## SECTION 1902

### QUALITY CONTROL PROGRAM FOR PRECAST CONCRETE PRODUCTS

#### 1902.1 DESCRIPTION

This specification covers precast concrete pipe, end sections, inlets, manholes, boxes, and related concrete accessories. This specification does not apply to prestressed concrete beams.

#### 1902.2 REQUIREMENTS

##### a. Materials.

(1) Use cement from a prequalified source that complies with **DIVISION 2000**. Make cement certifications available at the precast production site.

(2) Fly ash may be substituted for Types II or I/II Portland cement in concrete pipe at rates up to 25 percent. Use fly ash (for pipe only) from a source prequalified under **SECTION 2006**. The sources of cement, aggregates and fly ash must be prequalified for each plant by testing them together using Kansas Test Method KTMR-29, "Wetting and Drying Test of Steam Cured Reinforced Concrete Pipe with Fly Ash." If the mixture complies with the requirement, the producer and the KDOT plant inspectors will be notified in writing. Preliminary approval will be given for mixtures at 150 days based on satisfactory test performance of KTMR-29. If any of the sources of Cement, Fly Ash, or Aggregate are changed in the future, the test must be repeated using the same procedure before incorporating the new sources in the products. Testing may be waived if the same mixture of sources has been tested for another plant. Contact the Bureau of Materials and Research for information and to make arrangements for testing. Make these certifications available at the precast production site.

(3) Aggregates. Use aggregates that comply with "Aggregates for Concrete" as shown in **DIVISION 1100** of the Standard Specifications except that the gradation requirements do not apply. Also, update aggregate producer's certifications at 6-month intervals and when aggregate source changes are made. Make these certifications available at the precast production site.

(4) Use admixtures and blends from a prequalified source as specified in AASHTO M 170, AASHTO M 206 or AASHTO M 207, as applicable. The supplementary optional physical requirements of AASHTO M 295 apply for pozzolanic admixtures except as stated in 1902.2a(2). Make certifications for admixtures and blends available at the precast production site.

Regular admixtures that are tested using ASTM C 494 or ASTM C 1017 procedures are prequalified by complying with **DIVISION 1400**. Admixtures prequalified in this way are listed in prequalified list PQL-2.1, "List of Prequalified Admixtures for Water Reduction, Acceleration, Set Retardation and Plasticizing of Portland Cement Concrete."

Admixtures that are developed for zero slump concrete, and are not tested by admixture producers using ASTM C 494 or ASTM C 1017 procedures, are prequalified by submitting the material to the Engineer of Tests for evaluation and testing. Submit technical data sheets, test reports, material safety data sheets, an IR trace and a 1-quart sample. The admixture will be evaluated for long term durability similar to fly ash by testing it using Kansas Test Method KTMR-29, "Wetting and Drying Test of Steam Cured Reinforced Concrete Pipe with Fly Ash." If the mixture complies with the requirement, the producer and the KDOT plant inspectors will be notified in writing. Preliminary approval will be given for mixtures at 150 days based on satisfactory test performance of KTMR-29. Admixtures prequalified in this way are listed in prequalified list PQL-2.3, "List of Prequalified Admixtures for Zero Slump Concrete."

(5) Use steel reinforcement as specified in AASHTO M 170, AASHTO M 206 or AASHTO M 207, as applicable. Make certifications for steel reinforcement available at the precast production site. All steel components utilized in the products, reinforcing and structural must comply with **DIVISION 1600**.

**b. Pipe.** Supply pipe, either elliptical, arch or round, as designated in the Contract Documents and complying with either AASHTO M 170 for round pipe, AASHTO M 206 for arch pipe or AASHTO M 207 for elliptical pipe with the following additions or deletions:

(1) Classes of Pipe. Provide only Class II or stronger round pipe, Class HE-II or stronger elliptical pipe, or Class A-II or stronger arch pipe.

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(2) Sizes of pipe. The minimum diameters of round pipe and the minimum waterway areas of elliptical pipe and arch pipe will be shown in the Contract Documents. Pipe having larger diameters or waterway areas may be provided the Engineer approves any substitutions. The nominal waterway areas for various sizes of arch pipe are as shown in AASHTO M 206 and for various sizes of elliptical pipe are as shown in AASHTO M 207.

(3) Delete the permissible variations in internal diameter as shown in AASHTO M 170, M 206, or M 207 as applicable, and replace with the following:

For round pipe, the permissible variation in internal diameter is  $\pm 1\%$  from the design diameter for the first 9 inches measured from the inside edge of each end of the pipe and  $\pm 3\%$  from the design diameter for the remainder of the pipe.

For arch pipe, the permissible variation in internal diameter is  $\pm 2\%$  from the rise and span as shown in Table 1 and Figure 1 of AASHTO M 206 for the first 9 inches measured from the inside edge of each end of the pipe and  $\pm 3\%$  from the rise and span shown in Table 1 and Figure 1 of AASHTO M 206 for the remainder of the pipe.

For elliptical pipe, the permissible variation in internal diameter is  $\pm 2\%$  from the rise and span as shown in Table 1 and 2 of AASHTO M 207 for the first 9 inches measured from the inside edge of each end of the pipe and  $\pm 3\%$  from the rise and span shown in Table 1 and 2 of AASHTO M 207 for the remainder of the pipe.

(4) Lift Holes. One lift hole, not to exceed 4 inches in diameter, may be provided in each section of pipe. After placement, fill lift holes with a suitable concrete mortar, unless directed otherwise by the Engineer.

### c. End Sections

(1) Fabricate beveled end sections from pipe complying with this specification for Class II, Class A-II or Class HE-II pipe, as applicable. Bevel to comply with the dimensions shown on the Contract Documents.

(2) Fabricate flared end sections complying with the concrete compressive strength, the absorption, the steel area and the workmanship requirements of this specification for Class II, Class A-II or Class HE-II pipe, as applicable.

(3) Two lift holes, not exceeding 4 inches in diameter, will be permitted in each section. After placement, fill lift holes with a suitable concrete mortar, unless directed otherwise by the Engineer.

**d. Manholes, Inlets, and Boxes for Storm Water Drainage.** Fabricate manholes, inlets, and boxes for storm water drainage complying with the KDOT approved shop drawings, including reinforcement, absorption, and concrete strength.

**e. Manholes, Inlets, and Boxes for Sanitary Sewer Drainage.** Fabricate manholes, inlets, and boxes for sanitary sewer drainage complying with the KDOT approved shop drawings and ASTM C 478.

### 1902.3 TEST METHODS

a. The following current test methods and property requirements, AASHTO or the ASTM equivalent are to be applied to procedures referenced in this specification.

(1) AASHTO T-22, "Compressive Strength of Cylindrical Concrete Specimens." Apply the single operator precision statement for field conditions from ASTM C-39.

(2) AASHTO T-23, "Making and Curing Concrete Test Specimens in the Field."

(3) AASHTO T-24, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."

(4) AASHTO T-119, "Slump of Hydraulic Cement Concrete."

(5) AASHTO T-121, "Weight per Cubic Foot, Yield and Air Content (Gravimetric) of Concrete."

(6) AASHTO T-126, "Making and Curing Concrete Test Specimens in the Laboratory."

(7) AASHTO T-196, "Air Content of Freshly Mixed Concrete by the Volumetric Method."

(8) AASHTO T-152, "Air Content of Freshly Mixed Concrete by the Pressure Method." Not applicable, without special calibration, in the following conditions:

- Slump  $\leq 2$  inches.
- A mid-range or high-range water-reducer is used.
- An air-entraining agent other than a vinsol resin is used.
- Non-plastic concrete such as commonly used in the manufacture of pipe and concrete masonry units.

(9) AASHTO T-231, "Capping Cylindrical Concrete Specimens."

(10) ASTM C-497, "Concrete Pipe, Manhole Sections, or Tile." (Suggested minimum amplitude of 5 mils.)

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(11) Kansas Test Method KTMR-29, "Wetting and Drying Test of Steam Cured Reinforced Concrete Pipe with Fly Ash."

b. Cylinders are to be 6Ø X 12-inch, however 4Ø X 8-inch cylinders may be approved by the KDOT provided reliable correction factors are developed. Include both uncorrected and corrected data in the quality control summary reports.

c. Compressive strength testing of a minimum of two 28-day laboratory cured cylinders is required for each mix design of a producer. The five lot moving average will apply to each mix design.

d. Cure optional shipping strength cylinders under the same conditions as the product they represent. Test a minimum of 2 cylinders for shipping strength at the same age. Attain a minimum of 80 percent of the specified 28-day compressive strength for the product on each cylinder before shipping. These products are still subject to the requirements of this section and final approval at the project site. Note in the monthly report which products are shipped after 28 days of age, therefore not requiring shipping strength data.

When shipping strength cylinders are utilized, a minimum of 1 set is to be produced at the same time period and from the same concrete batch as the 28-day compressive strength cylinders. Additional shipping strength cylinders may be produced at other times from different concrete batches and tested if desired. Submit all shipping strength data to KDOT and provide availability to the inspector at the production site.

e. The individuals conducting quality control sampling and testing for all producers are to be certified by ACI, or a KDOT approved equivalent, in the appropriate method(s) of sampling and testing, or the laboratory must be AASHTO accredited. Provide copies of the certifications to the KDOT. Notify the KDOT within 2 months of any changes in certification status or QC testing personnel.

### 1902.4 PRODUCER PREQUALIFICATION

#### a. Becoming Prequalified.

(1) Notify KDOT of desire to prequalify. Produce 5 lots of concrete that would be used on KDOT products. Provide 28-day compressive strength test data for all 5 lots. Allow KDOT to sample and test 1 of the 5 lots. This sample will be a split sample, with KDOT and Producer testing essentially the same product. The maximum variation between the average of the Producer's 5 lots and KDOT's test results is 10%.

(2) Demonstrate that all highway and bridge construction industry related products manufactured at each facility are produced under a Quality Control Program. Present a Quality Control Plan to the KDOT, Chief of Materials and Research, for evaluation and disposition. The plan must provide the following information as the minimum requirements:

- Name and location of the producer's facility.
- Name, telephone number, level of authority (organizational chart), and qualifications of the persons and alternates directing quality control at the facility. One of these individuals must be present during production at the facility.
- The name and location of the laboratory, whether internal or external to the facility, conducting the quality control testing for the producer. A listing of any accreditation of the laboratory as well as the frequency of NIST traceable equipment calibrations is required.
- Except as described in **subsection 1902.4a(4)**, a lot is defined as the production from each mix design during the 7 consecutive day period beginning Sunday and ending Saturday of each week. Test 1 lot from each mix design used at the facility during this 7-day period. Lot size is 7 consecutive days regardless of the size or type of product or whether the mix is used only once during that 7-day period or each of the 7 days.
- List the QC tests to be performed, including which tests are used for shipping strength. Define the method for obtaining random samples for each test and the number of samples to be tested per lot.
- The frequency of submitting quality control summary reports. This is not to be less than 1 report per month.

(3) The program will be reviewed, and if found acceptable, the producer's facility will be placed on a list of prequalified precast product sources maintained by the Bureau of Materials and Research.

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(4) Upon approval by the Engineer, Producers that demonstrate a continually low monthly production rate, or do not continually provide products to KDOT may base their lots on a per unit basis, not to exceed 1 month. Producers of manholes, inlets, boxes and other project specific products that choose this option must notify the Bureau of Materials and Research when producing KDOT products. KDOT may also choose to decrease the frequency of verification sampling, testing and production monitoring for any Producer.

### **b. Maintaining Prequalified Status.**

(1) Monitor on a lot by lot basis for each mix design or product the 5 lot moving average of compressive strength,  $\bar{X}_t$ ; the  $n - 1$  weighted standard deviation of the 5 test values used to determine the moving average,  $S_t$ ; the quality index,  $Q_L$ ; and the associated percent within limits (PWL) as referenced in the Terminology and Definitions.

Notify KDOT of changes in mix designs, concrete materials sources, mixing equipment, or sources of concrete. Changes that significantly affect the control charts may constitute a new mix design and therefore require a new five lot moving average. Produce 5 successive lots complying with the minimum strength requirements for each new mix design.

Selection of the production lot or test number,  $t$  is important since it determines the 5 test moving average. Since  $t$  is an integer, it is suggested that for the first lot, set  $t = 1$ , increment by 1 for each successive lot.

A producer, at their option, may impose a more stringent quality control requirement than the five lot moving average. Inform the KDOT as to the frequency of quality control testing, the PWL, the production quantity represented by the test or tests, other types of control monitoring such as attributes, variables, tracking and traceability methods, etc. The Producer and the KDOT must mutually agree upon this program.

The frequency of sampling and testing may be decreased with the approval of the KDOT if proficiency in maintaining the quality control of the products is demonstrated to the satisfaction of the KDOT.

(2) Clearly mark the lot when any single cylinder test value for that lot has a final strength of less than 85 percent of the specified minimum 28-day compressive strength. Clearly mark this material to prevent it from being included in a KDOT project and store it separately from the approved material.

(3) Comply with a 90 percent within limits (PWL) requirement relative to the minimum specified 28-day compressive strength for the 5 lot moving average. The Lower Spec Limit (LSL) for each product is that product's required 28-day compressive strength. Notify the KDOT immediately whenever the 5 lot moving average falls below 90 PWL, and comply with the following. Produce 5 successive lots complying with the minimum strength requirements as agreed upon by KDOT and the Producer, and provide documentation that corrective action has been taken and that compliance has been reestablished.

(4) Maintain optional control charts of  $\bar{X}_t$ ,  $S_t$  and PWL vs. test number  $t$ .

(5) Display plant name, initials, or logo, date manufactured, AASHTO class when applicable, and size on all inventories. Clearly mark all products not intended for KDOT use. Maintain traceability of all products shipped to KDOT projects.

(6) The producer's facility will be randomly visited to inspect the placement of the steel and other necessary requirements for the project.

(7) Provide KDOT with the current week's production schedule at the beginning of each week. Verification samples will be taken at a minimum of once every 5 lots for each product. This may include, but is not restricted to, any combination of cylinders, core samples, and, for pipe, 3-edge bearing tests. The same statistical parameters ( $\bar{X}_t$ ,  $S_t$  and PWL) will be developed from the verification test data of the cylinders. Under normal conditions, no more than 10 pieces of pipe per year will be tested to ultimate strength when the 3-edge bearing test is used for verification testing.

(8) A minimum of 5 of the KDOT's verification test results will be compared with the associated producer's quality control tests through the F and t statistical test to determine if they represent the same population. Continual deviations will be rectified with the Producer.

(9) Any unacceptable practices witnessed by KDOT personnel at the producer's facility may result in loss of Prequalified Status if not corrected or eliminated after notification.

**c. Terminology and Definitions.** Refer to 5.17.09 in Part V for terminology and definitions concerning QC/QA and Statistical Analysis.

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### d. Monthly Report Requirements

- (1) Include the following information in the quality control summary reports.
  - Clear and consistent identification of each mix design and test samples. Use only 1 producer defined lower specification limit for each mix design.
  - The date the sample, product, or cylinders were produced and the dates tested for both shipping strength and 28-day compressive strengths of laboratory cured cylinders. Include documentation when products are not shipped before 28 days, therefore waving the shipping strength requirements.
  - The load at failure, compressive strength, applicable correction factor, and corrected strength, for each individual sample tested as per **subsection 1902.3c**.
  - The statistical analysis of this data as described in **subsection 1902.4b(1)** and the optional control charts.
- (2) Do not send QC Reports for products that are not normally used in the highway and bridge construction industry.
- (3) Reports that are more than 2 months late will cause a loss of Prequalified Status for a 6-month period. Further delinquent reports may cause permanent loss of Prequalified Status.
- (4) Make available the actual test data and reports, including shipping strength data, to the inspector at the production site. Test reports are to bear the names and signatures of the certified technicians or representative of the laboratory conducting the sampling and testing. For precast facilities that are performing their own QC testing, actual data records are to be initialed by the certified technicians conducting the testing. Make available for inspection the shipping records for KDOT projects.

### 1902.5 BASIS OF ACCEPTANCE

Delete the basis of acceptance in AASHTO M 170, AASHTO M 206 and AASHTO M 207, and replace with the following:

- a. Prequalification as required by **subsection 1902.4**.
- b. Receipt and approval of a Type C certification as specified in **DIVISION 2600**.
- c. All products governed by this special provision are subject to final visual inspection for shipping damage, fit and other visual defects, and disposition when delivered to the project site.