



## REINFORCED CONCRETE CULVERT STORM DRAIN AND SEWER PIPE FIELD SECTION 1026

**1026.1 SCOPE.** To establish procedures for the inspection of reinforced concrete pipe and the approval of modified or special designs for reinforced concrete pipe.

### 1026.2 APPARATUS.

- (a) Micrometer capable of measuring to 0.0001 in. [0.00254 mm] and accurate to within at least 0.001 in. [0.0254 mm].
- (b) Leaf gauge 0.01 in. [250  $\mu$ m] in thickness, ground to a point 1/16 in. [1580  $\mu$ m] wide and tapered 1/4 in. [250  $\mu$ m] per in.
- (c) Rule with suitable graduations to accurately measure the material to be inspected.
- (d) OK - MoDOT stamp.
- (e) Weather resistant marking materials.

**1026.3 PROCEDURE.** Two separate and alternate bases of acceptance of concrete pipe are allowed by the specifications. Method No. 1 requires a three-edge bearing test; approval of materials incorporated into the pipe; absorption tests; and visual examination of the finished pipe. Method No. 2 requires approval of materials incorporated into the pipe; compressive tests on cores or cylinders; absorption tests; and inspection of the finished pipe including quantity and placement of reinforcement. These two alternate methods are the means of inspection for acceptance, however, all pipe must meet all requirements of Specification Sec 1026 pertaining to the class and design of pipe being inspected. For instance, concrete cylinders may be made and tested to verify concrete design compressive strength even though Method No. 1 is being used as a basis for acceptance.

**1026.3.1** Fine and coarse aggregate shall conform to the requirements of Specification Sec 1005, except that requirements for gradation and percent passing the No. 200 [75  $\mu$ m] sieve shall not apply. Fine aggregate and coarse aggregate are defined as:

- (a) Fine Aggregate - aggregate passing the 3/8-in. [9.5 mm] sieve and almost entirely passing the No. 4 [4.75 mm] sieve and predominantly retained on the No. 200 [75  $\mu$ m] sieve or as that portion of an aggregate passing the No. 4 [4.75 mm] sieve and retained on the No. 200 [75  $\mu$ m] sieve, and;
- (b) Coarse Aggregate - aggregate predominantly retained on the No. 4 [4.75 mm] sieve or as that portion of an aggregate retained on the No. 4 [4.75 mm] sieve.



Fine and coarse aggregate are to be from approved sources of the type of material specified in Specification Sec 1005 and shall meet the quality requirements of that specification, except that gradation requirements and percent passing the No. 200 [75 µm] sieve do not apply. The procedures for inspecting these aggregates are described in [Field Sec 1001](#) and [Field Sec 1005](#) of this Manual. The aggregates may be inspected and reported at the source of manufacture or at the pipe manufacturing plant.

**1026.3.2** Cement shall meet Specification Sec 1019. Approved Class C or F fly ash may be used to replace a maximum of 15 percent of Type I or II cement on an equivalent weight [mass] basis. Fly ash shall not exceed 15 percent by weight [mass] of the total cementitious material, i.e., microsilica, steel slag or other pozzolanic material. The district Operations Engineer is to establish files to reflect that cementitious materials used in the manufacture of concrete pipe for Department projects were properly inspected.

The pipe manufacturer is required to maintain a file of bills of lading or delivery receipts of cementitious materials, showing the certification statements required, which are to be readily available to the inspector. Samples of cementitious materials shall be taken as shown below. If a pipe manufacturer is using more than one brand of cement or flyash, the samples should be taken alternately to cover different brands. Samples shall be placed in a canvas bag containing a plastic liner and shipped to the Laboratory. The sample is to be assigned a sample ID number and the associated sample record shall include the silo, truck or car number, manufacturer, and other pertinent information. The sample shall be submitted as "General".

**1026.3.2.1 Cement Samples.** A sample weighing a minimum of 5 pounds [2 kg] shall be taken for approximately every 750 tons [680 Mg] of cement used for Department projects or for every 30 production days on which pipe was produced for Department projects, whichever occurs first.

**1026.3.2.2 Flyash Samples.** A sample weighing a minimum of 5 pounds [2 kg] shall be taken for approximately 200 tons [180 Mg] of fly ash used for Department projects or for every 30 production days on which pipe was produced for Department projects, whichever occurs first.

**1026.3.3** The concrete mixture is to be homogeneous throughout production. The pipe manufacturer is responsible for the mix design and proportioning with the restriction that a minimum of 564 pounds [335 kg] of cement per cubic yard [meter] is required. Admixtures may only be used with written approval of General Headquarters Materials. The inspector should acquaint himself with production facilities and procedures. He should verify that the concrete mix does contain 564 pounds [335 kg] or more of cement per cubic yard [meter].

**1026.3.4** Reinforcing steel for use in the manufacture of concrete pipe will be accepted according to the PAL process. The pipe manufacturer shall use only PAL material. The material shall be reported by the pipe manufacturer using the PAL receiver form. The pipe manufacturer shall retain certification and mill test reports for 2 years and make them available to the inspector when requested.

**1026.3.4.1** When samples are obtained for testing, they shall be taken as described in [Field Sec 1036](#) of this Manual, except for Welded Wire Fabric. Welded wire to be sampled for Laboratory testing is to be field measured for size prior to sampling. Each circumferential wire across the width of the fabric is to be measured. The manufacturer may use over-sized wire in the fabrication of welded wire fabric, but not under-sized wire. The size differential shall not exceed one "W" size increment on sizes W8 and smaller and two "W" size increments on sizes



larger than W8. "W" sizes referred to are those shown in AASHTO M32. In all cases where over-sizing exists, the fabric shall be identified and used as that originally ordered or offered for use. If the wire does not meet the specification requirements, it is not to be sampled and submitted to the Laboratory. It is to be rejected in the field unless measurements are such that Laboratory verification is needed. When verification is needed, it should be so stated on the identification sheet accompanying the sample. Samples of welded wire fabric representing each lot shall consist of two pieces of longitudinal wire not less than 24 in. [600 mm] in length. Samples of the transverse wires are not required. A lot of welded wire fabric is 25000 sq. ft. [2300 sq.meter] or fraction thereof of one style of fabric with the same size wires and spacing. Regardless of the basis of acceptance of reinforcing steel for concrete pipe, it shall be field inspected for diameter and spacing of circumferential steel. The inspector is to examine laps and welds and, when required by Specification Sec 1026.13, a representative sample shall be taken for testing of welded laps or butt welds. Such a sample shall consist of two pieces, each with a clear length of 12 in. [300 mm] either side of the weld and is to be taken at least once a year for each size of steel welded and each length of lap being used.

**1026.3.4.2** Note that reinforcement of pipe wall may be either that specified under Circular Reinforcement or as under Elliptical Reinforcement. If the latter, special pipe marking is also required by Standard Specifications.

**1026.3.5** If a three-edge bearing test is required as a basis for acceptance, one section of pipe of each size, class, and type is to be tested in accordance with AASHTO T280 for each 300 lengths offered for inspection. If no size, class or type of pipe meets the criteria of 300 lengths in one year, a minimum of one test per year is to be performed, to ultimate load, on one of the sizes being furnished by that plant. Very often pipe with the most recent production date of those offered for inspection will be tested in three-edge bearing. This serves two purposes, verifying that the pipe meets three-edge bearing requirements and verifying that the newest pipe is suitable for shipment at the age tested. In case a pipe fails to meet the 0.01 in. [250  $\mu$ m] crack requirement; or ultimate load, if being tested to ultimate; two additional lengths may be tested from the same lot and the same production date. Both of these pipe shall pass or all pipe offered for inspection of that size and class are to be rejected, except the producer is to be given the option of testing two lengths of pipe with production dates older than those originally tested. If a production date is found to be satisfactory, pipe of that date or older may be accepted. When the three-edge bearing test is run to ultimate, the steel size and placement is to be checked in the broken barrel. Failures of three-edge bearing are cause to check fabricating procedures and compressive strength of the concrete mix.

**1026.3.6** When compressive strength of concrete is a basis of acceptance (Method No. 2), the compressive strength is to be determined at a frequency not less than for three-edge bearing and may be determined either by standard rodded concrete cylinders or cylinders compacted and cured in like manner as the pipe in accordance with AASHTO T23, or on cores drilled from the wall of the pipe in accordance with AASHTO T280. Testing for compressive strength and the application of test results is described in Specification Sec 1026.21. Occasional individual cylinders may fall below the design strength for some unknown reason. If the inspector feels an occasional individual cylinder of a paired set or a group of breaks is not representative of the process, it may be disregarded. However, not more than 10 percent of the cylinders tested shall fall below the design strength. In no case shall the strength of any cylinder tested fall below 80 percent of the design strength. Compressive tests may be performed in the field unless questionable results are being obtained in which case cylinders or cores are to be submitted to the Laboratory. SiteManager shall be used to identify cylinders and cores, to be submitted to



the Laboratory. The inspector is to change the distribution and title block shown on the form, as required. Cores or cylinders submitted to the Central Laboratory shall be identified according to GS-3.2.1. The exterior of the shipping carton shall have the following information listed: sample identification number, date of pour, cement factor (may be theoretical), cylinder numbers, and any special instructions.

**1026.3.7** Absorption test specimens are to be taken for each 300 lengths of each size, class, and type offered for inspection. If no size, class, or type of pipe meets the criteria of 300 lengths in one year, a minimum of one sample per year is to be taken on one of the sizes being furnished by that plant. Absorption samples may be a core cut from the full wall thickness or a specimen (recommended 5 x 5 inches [125 x 125 mm]) extracted from the broken wall of pipe tested to ultimate in three-edge bearing. In either case, the specimen shall be of a size to yield a minimum area of 9 square inches [5800 sq.mm] representing full wall thickness and free of cracks. Samples for absorption tests are to be submitted to the Laboratory. Samples submitted to the Central Laboratory shall be identified according to GS-3.2.1. Required supplemental information includes class, type, and wall thickness.

**1026.3.8** Fabricated pipe shall be inspected for diameter, wall thickness, laying length, workmanship, and marking.

**1026.3.8.1** Random measurements of diameter, wall thickness, and laying length should be made to ascertain that forms and manufacturing processes are yielding a finished pipe conforming to the specification requirements.

**1026.3.8.2** A visual examination of each length of pipe offered for inspection is to be made for workmanship. Individual sections of pipe may be rejected for:

- (a) Fractures or cracks passing through the wall except for a single crack in the bell or spigot which does not extend into the barrel of the pipe.
- (b) Defects that indicate imperfect proportioning, mixing, or molding. These defects may appear as non-uniform appearance such as concentrations of coarse aggregate or mortar and may be detected inside or outside the barrel. They may also appear as non-uniformity in lines or shape.
- (c) Surface defects indicating honeycomb or open texture. This defect may appear inside or outside the barrel or in the bell or spigot. If surface defects are a common fault at a plant, it may be advantageous to require the pipe to be placed so the entire outside barrel can be inspected.
- (d) Damages or unsatisfactory manufactured ends if such would prevent making a satisfactory joint. A small amount of surface exposure of steel may not be detrimental so long as the bell or spigot still has a smooth surface. Some honeycomb or open texture in the bell or spigot may be repairable. Chips from the bell or spigot of approximately 1/3 the depth of the joint may be tolerable, depending on extent of area affected.

Visual examination of concrete pipe requires a great amount of judgment and care from the inspector. The inspector should attempt to apply the same degree of severity to a defect from day to day. If visual examination shows that proper care is not being taken in either the

manufacture or handling of pipe, the manufacturer should be consulted as to possible permanent remedies of such faults.

**1026.3.8.3** Each length of concrete pipe is to be identified on the inside by the manufacturer by indenting on the pipe section or painting with waterproof paint the information required in Specification Sec 1026.25. Concrete pipe is to be inspected and reported as the class to which it was manufactured with one exception. A pipe may be marked down to a lower class only when it fails to meet the requirements of the class to which it was manufactured and it meets the requirements of the lower class. Pipe that is marked down shall have the original class completely obliterated by grinding or any other means necessary. The manufacturer shall be responsible for all markings and all pipe marked down shall be properly remarked prior to inspection at the origin.

**1026.3.9** Concrete pipe that has been inspected and found to conform with all requirements of the Specifications is to be marked by stamping "OK-MoDOT" on the inside of the barrel, in the bell end, near the class marking when possible. An "OK - MoDOT" placed on the pipe by a Materials inspector constitutes approval. Confirmation of inspection, and acceptance or rejection, is documented with a SiteManager sample record (AS-3510). The pipe is subject to inspection at destination for any damage that may have occurred in handling. If damage to previously accepted and marked pipe, either at the origin or destination, results in noncompliance to the specifications, the "OK-MoDOT" legend is to be obliterated. Concrete pipe that is offered for inspection and rejected at origin shall be marked on the outside vertical face of the bell with a single vertical mark. The rejection mark is to be of a material that is weather resistant enough to prevent reinspection of the same length of pipe. Concrete pipe that has been tested only to the formation of the 0.01 in. [250 µm] crack requirement and is accepted for use shall be identified as such by stenciling or marking inside the bell end of the barrel, "Pipe Tested" and stamping "OK-MoDOT" immediately after the word "Tested".

**1026.3.10** When gasketed concrete pipe is specified, the joints shall be Type A rubber gaskets conforming to the requirements of AASHTO M198. The pipe shall be inspected as described in this Section of the Manual and in addition, the manufacturer shall make tests (in the presence of the inspector) in accordance with Sec 8 of AASHTO M198 to demonstrate adequate performance. The manufacturer shall furnish a certification in triplicate that the physical and chemical properties of the gasket conform to all of the requirements of the specifications.

**1026.4 SPECIAL OR MODIFIED DESIGNS.** As permitted by Specification Sec 1026.10 a manufacturer may submit a special or modified design for approval. When a particular design is required to accommodate a d-load included in the plans, the manufacturer must submit a design for approval. The design is to be submitted by the manufacturer to the District that is responsible for the original inspection. The District will confirm that the design has been sealed by a Missouri registered professional engineer and that the parameters indicated are appropriate for the application. Designs not sealed are to be rejected. Designs that meet the criteria stated in this section may be accepted by the District and approved for production. A design submittal is to include a description of the pipe, i.e., wall thickness, concrete design compressive strength, and area, type, placement, and strength of the steel reinforcement; a detail drawing of the proposed design; and a copy of the complete design calculations. After a modified or special design is approved, the District is to require and observe proof of design tests from the manufacturer. Proof of design tests are to consist of at least two three-edge bearing tests for the load to produce a 0.01 in. [250 µm] crack and the ultimate strength; an absorption test from each of the pipes tested in three-edge bearing; and two concrete cylinders



for each pipe tested in three-edge bearing, molded from the same concrete as used in the production of that pipe section. If the concrete mix is too dry to make satisfactory cylinders, two cores from each of the pipe tested in three-edge bearing may be used for determining the compressive strength of the concrete mix. Approval of pipe, produced to meet a special or modified design, is dependent on tests on the manufactured pipe indicating compliance with the requirements of Specification Sec 1026.

### **1026.5 SAMPLE RECORD.**

**1026.5.1** Acceptance of each component of reinforced concrete pipe including fine and coarse aggregate, cement, fly ash, and steel shall be documented with a SiteManager record (AS-3510).

**1026.5.2** Results of three-edge bearing tests are to be reported on a form similar to that shown as Exhibit 1026-A of this Section. The District shall provide its own forms. Distribution of this form is to be as follows:

General Headquarters Materials  
Operations Engineer (fabricating District).

**1026.5.3** Results of field determination of compressive strength (cylinders or cores) shall be reported through SiteManager.

**1026.5.4** All pipe is to be inspected at the source and reported to the project through SiteManager. Acceptable pipe is to be reported to the project as soon as possible. Pipe quantity shall be shown in feet. End sections shall be shown as quantity each. The length of barrel of the end sections shall be included in the remarks and shall not be counted toward the materials summary unless the length contributed is necessary to eliminate a significant summary deficiency. Rejected pipe is to be reported as "General" rather than a project and the report should contain a brief statement as to the causes of rejection. When shipments of inspected pipe are made to another producing plant, all pipe shall be reported as "General" to the District involved, as soon as possible. The intermediate District shall then be responsible for the reporting to the project.

**1026.5.5** Rubber gasket joint materials will be from a PAL supplier and will be reported through SiteManager. They may be included on the same sample record as accepted concrete pipe. The pipe manufacturer shall report receipt of gasket material using the PAL receiver form and shall retain a copy of the certification for a period of 2 years.



### Report of Tests on Concrete Pipe

SOURCE OF PIPE Artmus Concrete Pipe Co. LOCATION Artmus, MO DATE 2-11-74

CEMENT (LBS/BATCH) 1200 FINE AGG.(LBS/BATCH) 4200 COARSE AGG.(LBS/BATCH) 1300

PIPE DIA	PIPE LENG.	CLASS	WALL	DATE MADE	AGE (DAYS)	STEEL		AREA	.01 CRACK		ULTIMATE LOAD	
						GAGE SPEC.			REQUIRED	ACTUAL	REQUIRED	ACTUAL
12.00	6'0"	3.00	B	1-25-74	28.00	7.00	3.00	.098	8,100	13,000	12,000	30,000
12.00	6'0"	3.00	B		28.00	7.00	3.00	.098	8,100	16,900	12,000	30,000
15.00	6'0"	3.00	B		28.00	7.00	3.00	.098	10,125	14,600	15,000	30,000
18.00	6'0"	3.00	B		28.00	7.00	3.00	.098	12,150	12,200	18,000	20,000

INSPECTOR \_\_\_\_\_

TITLE \_\_\_\_\_

Exhibit 1026-A



MATERIALS

Report of Tests on Concrete Pipe (Metric)

SOURCE OF PIPE \_\_\_\_\_ LOCATION \_\_\_\_\_ DATE \_\_\_\_\_

CEMENT (Kg/BATCH) \_\_\_\_\_ FINE AGG.(Kg/BATCH) \_\_\_\_\_ COARSE AGG.(Kg/BATCH) \_\_\_\_\_

PIPE DIA mm	PIPE LENG. meter	CLASS	WALL	DATE MADE	AGE (DAYS)	STEEL		AREA	250 m CRACK		ULTIMATE LOAD	
						GAGE	SPEC.		REQUIRED	ACTUAL	REQUIRED	ACTUAL

INSPECTOR \_\_\_\_\_  
 TITLE \_\_\_\_\_

Exhibit 1026-B