

KTMR-29 WETTING AND DRYING TEST OF STEAM CURED REINFORCED CONCRETE PIPE WITH FLY ASH

a. SCOPE

This test shall be used to determine the acceptability of steam cured reinforced concrete pipe with fly ash.

b. REFERENCED DOCUMENTS

- b.1.** AASHTO T 126; Making and Curing Concrete Test Specimens in the Laboratory
- b.2.** AASHTO T 140; Compressive Strength of Concrete Using Portions of Beams Broken in Flexure
- b.3.** AASHTO T 177; Flexural Strength of Concrete [Using Simple Beam With Center Point Loading]
- b.4.** AASHTO M 231; Balances Used in the Testing of Materials

c. APPARATUS

- c.1.** Molds suitable for casting 76.2 X 101.6 X 406.4 mm (3 X 4 X 16 in) beams.
- c.2.** Rotary concrete mixer as specified in AASHTO T 126.
- c.3.** A balance of sufficient capacity conforming to requirements of AASHTO M 231.
- c.4.** A drying oven capable of maintaining a temperature of 53.3-54.4°C (128-130°F).
- c.5.** Water bath capable of maintaining a temperature between 15.6-26.7°C (60-80°F).
- c.6.** Length comparator capable of accurately reading beams to the nearest 0.01 mm (0.001 in).
- c.7.** A testing machine for modulus of rupture determination as specified in AASHTO T 177.
- c.8.** A 15.9 mm (5/8 in) diameter steel rod having a hemispherical tip the same diameter as the rod.
- c.9.** A vibrating table meeting the requirements of AASHTO T 126.

d. SAMPLE PREPARATION

- d.1.** The pipe manufacturer provides the mix design and all materials.
- d.2.** Cast six 76.2 X 101.6 X 406.4 mm (3 X 4 X 16 in) beams as described below, and remove from the molds as soon as possible or within 2 hours from time of casting. Beams should be protected from loss of moisture during mold removal. Identify each beam for future tracking.

- d.2.a.** Place the concrete in the molds taking care to ensure each scoop is representative of the mix. Move the scoop around the edge of the mold as the concrete is discharged to minimize segregation and to ensure uniformity of distribution. Further distribute the concrete by use of a tamping rod prior to consolidation. Do not add nonrepresentative concrete to an under filled mold.
- d.2.b.** Place the concrete in the mold in four layers of approximately equal volume. Rod each layer continuously while vibrating. Rod the bottom layer throughout its depth, distributing the strokes uniformly over the cross section of the mold. For the upper layer, allow the rod to penetrate about 12.7 mm (1/2 in) into the bottom layer. Finish the surface with a wood float using the minimum amount of manipulation necessary to produce a plane surface that is essentially level with the top edge of the mold.
- d.3.** After removal of the molds from the beams, cure with steam following normal plant procedures.
- d.4.** On the following day pick up beams at the plant, return to laboratory and obtain cured (dry) mass and length. Place beams in water bath maintained at 15.6-26.7°C (60-80°F) for a minimum of 1 hour. Obtain mass in water & saturated surface dry (SSD) to determine the specific gravity as specified in **g.1**.
- d.4.a.** During the length determination, select the three best fitting beams for 335-day cycling. Best fitting pertains to the ability of the beam to fit in the comparator with pins fully aligned and minimal rocking motion.
- d.5.** The remaining beams shall be cured in the moist room for 28 days and broken in flexure at 30 days.

e. PROCEDURE

- e.1.** Measure length of beams at the following ages: 30, 60, 90, 120, 150, 180, 240, 300, and 365 days. At each age the beams shall be submerged in water maintained between 15.6-26.7°C (60-80°F) for not less than 15.5 ± 0.5 hours prior to measurement.
- e.2.** Thirty days after casting, test the three beams cured in the moist room for modulus of rupture as specified in AASHTO T 177. Conduct the test with the 76.2 X 406.4 mm (3 X 16 in) faces perpendicular to the applied load, with the load applied at the center of a 355.6 mm (14 in) span.
- e.2.a.** Upon completing the modulus of rupture test, break both halves of the beams in accordance to AASHTO T 140 (See **Figure 1**).

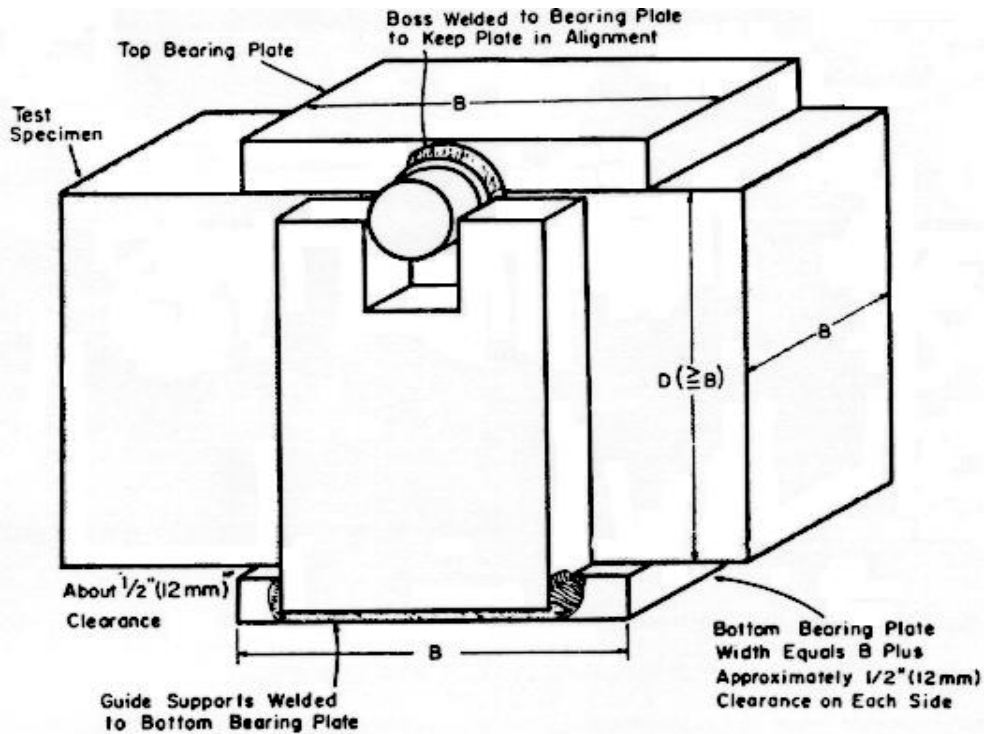


Figure 1

e.3. Beginning 5 days after casting, subject the other three beams to the following wetting and drying test procedure.

e.3.a. Place the beams in the oven maintained at 53-54°C (128-130°F) for eight hours.

e.3.b. Remove the beams from the oven and submerge them in the water bath at 16-27°C (60-80°F) for 15.5 ± 0.5 hours. Procedure (e.3.a.) and (e.3.b.) constitutes one cycle and shall be completed in 24 hours.

e.3.c. Repeat the cycle each consecutive day throughout the 365-day period except for weekends and holidays when the beams are to remain in the water bath.

e.4. Calculate and record the length change, expressed as percent expansion, at each of the ages stated under (e.1.) using the length measured at 30 days as the base as specified in g.2.

e.5. The beams shall be tested for modulus of rupture, upon completion of the 365-day test. The test shall be conducted with the 76.2 X 406.4 mm (3 X 16 in) faces perpendicular to the applied load, with the load applied at the center of a 355.6 mm (14 in) span as specified in AASHTO T 177.

e.6. Upon completing the modulus of rupture test, subject each half to a compressive strength test in accordance to AASHTO T 140.

f. REQUIREMENTS FOR ACCEPTABILITY OF REINFORCED CONCRETE PIPE WITH FLY ASH

f.1. Each of the two groups of beams tested in flexure at 30 days and 335 days shall have an average modulus of rupture of not less than 3.8 MPa (550 psi).

f.2. Expansion of beams:

f.2.a. At 150 days, the increase in length shall not exceed 0.050%.

f.2.b. At 335 days, the increase in length shall not exceed 0.070%.

g. CALCULATIONS

g.1. Bulk Specific Gravity:

$$G_{sb} = \frac{A}{B - C}$$

Where:

A = Mass of cured beam, g

B = Saturated surface-dry beam, g

C = Mass of beam in water, g

g.2. Percent expansion of beam:

$$\Delta L\% = \frac{100(L_n - L_{30})}{L_{30}}$$

Where:

$\Delta L\%$ = Percent change in length

L_{30} = Length of specimen at 30 days

L_n = Length of specimen at n days (n=60, 120, 180, 240, 300, or 365 days)

h. REPORT

See attached report.

KANSAS DEPARTMENT OF TRANSPORTATION

Sample of: Wetting and Drying of Concrete Pipe with Fly Ash (Final Report) Laboratory No.: 04-2848

Spec. No: Special Provision 90P-227 Date received: 07/28/04
Property of: Cretex Concrete Products Midwest, Inc. (00027401) Date reported: 06/29/05
Sample from: Kansas City Plant (Bonner Springs, KS)
Submitted by: R. Montney
Identifying Marks: Dry Cast (# 10) with FA Mix Design (Steam Cure)

TEST RESULTS

This material was tested in accordance with Special Provision 227 latest revision.

MATERIALS

Aggregate(Fine): Holliday Sand (Plant #7)(003735 1-2) Flyash: LaFarge (Weston, MO)(00-0189-02)
Aggregate(Coarse): Shawnee Rock (806601)(803701) Admixture: W.R.Grace Mark V Admixture:
Cement: Holcim I/II (Mason City, IA) (00007503)

MIX DESIGN

Date Made: 07/28/04 Fine Agg., kg (lbs.): 800.59(1765)
Cement, kg (lbs.): 212.73 (469) Flyash, kg (lbs.): 70.76(156)
Water, kg (lbs.): 99.34 (219) Admixture: 18.0 oz.
Coarse Agg., kg (lbs.) 659.98 (1455) Water/Cement Ratio: 0.35

TEST DATA

Modulus of Rupture MPa (PSI) Change in Fund, Frequency
Specimen Uncorrected Corrected Length (%) (% 30 day reading)

Note: The corrected modulus of rupture MPa (psi) is for information only.

Avg. @ 30 days					
04-2742 DC#10-4				0.013	
04-2742 DC#10 - 5				0.011	
04-2742 DC#10-6				0.010	112.83
Avg. @ 147 days				0.011	
04-2742 DC#10-4	7.44 (1079)	6.91 (1002)		0.020	
04-2742 DC#10-5	6.80 (986)	5.71 (828)		0.015	
04-2742 DC#10-6	6.67 (967)	6.43 (932)		0.016	113.90
Avg. @ 335 days		6.97(1011)	6.35 (921)	0.017	

NOTE: 224 cycles of wetting & drying.

DISPOSITION:

This material meets the requirements of Special Provision 227, latest revision and is approved for use.

cc: L. S. Ingram (3)
File

Reported by:
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Engineer of Physical Tests.