

**KTMR-23 WETTING AND DRYING TEST OF SAND AND SAND-GRAVEL AGGREGATE FOR CONCRETE**

**a. SCOPE**

This test shall be used to determine the acceptability of sand and sand-gravel aggregate to be used in concrete construction, both pavement and structural.

**b. REFERENCED DOCUMENTS**

**b.1.** AASHTO T 119; Slump of Hydraulic Cement Concrete

**b.2.** AASHTO R 39; Making and Curing Concrete Test Specimens in the Laboratory

**b.3.** AASHTO T 177; Flexural Strength of Concrete [Using Simple Beam With Center Point Loading]

**b.4.** AASHTO M 231; Weighing Devices Used in the Testing of Materials

**b.5.** ASTM C511; Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

**c. APPARATUS**

**c.1.** Molds suitable for casting 3 X 4 X 16 in beams.

**c.2.** Rotary concrete mixer as specified in AASHTO R 39.

**c.3.** A balance of sufficient capacity conforming to requirements of AASHTO M 231.

**c.4.** Slump cone and rod as specified in AASHTO T 119.

**c.5.** A drying oven capable of maintaining a temperature of 128 - 130°F.

**c.6.** Water bath capable of maintaining a temperature between 60 - 80°F.

**c.7.** Length comparator capable of accurately reading beams to the nearest 0.001 in.

**c.8.** A testing machine for modulus of rupture determination as specified in AASHTO T 177.

**c.9.** A 5/8 in diameter steel rod having a hemispherical tip the same diameter as the rod.

**d. SAMPLE PREPARATION**

**d.1.** Cement: Use Monarch, Type I/II cement. If not available, then use the cement type and brand designated by the Engineer of Tests.

**NOTE a:** The requirement for Monarch Type I/II cement exists because of its alkali level is as close to, but not exceeding, the 0.6% maximum.

**d.2.** The gradation of the aggregate shall be within the middle 1/3 of the limits specified in **Table 1** except for the 3/4 in sieve. It shall be further prepared by screening over the 3/4 in sieve and all material retained on the 3/4 in sieve shall be crushed to pass the 3/4 in sieve and incorporated into the mix.

Table 1 Percent Retained - Square Mesh Sieves								
3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8	No. 16	No. 30	No. 50	No.100
0-5	...	...	20-60	...	...	76-84	90-96	...

**d.3.** Run the specific gravity and absorption tests in accordance with KT-6 procedure I & II of the Part V Construction Manual. Run tests on the as-received material.

**d.3.a.** Using the results from the specific gravity and absorption tests, determine the average specific gravity and absorption in a 40 / 60 mix of dry material. The mix represents 40% being + 4 material and 60% being - 4 through + 200 material.

**d.3.b.** Recombine the material to the following schedule to produce three 40 lb batches.

- 1/2" - 0.8 lb
- 3/8" - 5.2 lb
- #4 - 10.0 lb
- #8 - 6.0 lb
- #16 - 4.0 lb
- #30 - 6.0 lb
- #50 - 5.2 lb
- #100 - 2.0 lb
- #200 - 0.8 lb

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Total - 40.0 lb

**d.3.c.** Place the material into galvanized or rust resistant pans, add the amount of water equal to the absorption and mix uniformly. Cover the material with a plastic sheet and let stand for approximately 4 hours in order to reach a saturated surface dry condition.

**d.4.** Create a concrete mix having a water/cement ratio of 0.51 and having a slump of 2 in and 3 in. Place two 40 lb batches of aggregate, design weight of cement and water in the mixer and start mixing. Using the third aggregate batch to bring mix to the desired slump.

**d.5.** Cast six 3 X 4 X 16 in beams as described below and remove from the molds within  $24 \pm 8$  hours from time of casting. Beams should be protected from loss of moisture during mold removal. Identify each beam for future tracking.

**d.5.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 underfilled mold.

**d.5.b.** Place the concrete in the mold in two layers of approximately equal volume. Rod each layer 32 times with the rounded end of the rod. 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 1/2 in into the bottom layer. After each layer is rodded, spade the concrete around the edges of the mold with a trowel or spatula. The molds containing the concrete shall then be tapped lightly on the table top to close any remaining voids. 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.6.** Cure the beams 7 days in a “moist room” that follows ASTM C511, then 21 days in air in a “cement mixing room” according to ASTM C511.

**d.7.** At 28 days obtain cured (dry) mass and length. Place beams in water bath maintained at 60 - 80°F for a minimum of 1 hour. Obtain mass in water & saturated surface dry to determine the specific gravity as specified in **g.1**. Place beams back in water bath for 48 hours.

**NOTE b:** Differences in specific gravity between the six beams can be an indication of air entrapment or poor consolidation in specimens.

**d.7.a.** During the length determination, select the three best fitting beams for 365-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.8.** The beams to be tested in flexure at 60 days shall then be cured in the moist room for an additional 30 days.

## **e. PROCEDURE**

**e.1.** Measure length of beams at the following ages: 30, 60, 120, 180, 240, 300, and 365 days. Make every attempt to choose a time when the 30, 60 and 365 day checks can be guaranteed. Other dates should fall within plus or minus one day. At each age the beams shall be submerged in water maintained between 60 - 80°F for not less than  $15.5 \pm 0.5$  hours prior to measurement.

**e.2.** Sixty 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 3 X 16 in faces perpendicular to the applied load, with the load applied at the center of a 14 in span.

**e.3.** Beginning 30 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 128 - 130°F for eight hours.

**e.3.b.** Remove the beams from the oven and submerge them in the water bath at 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 3 X 16 in faces perpendicular to the applied load, with the load applied at the center of a 14 in span as specified in AASHTO T 177.

## **f. REQUIREMENTS FOR ACCEPTABILITY OF THE AGGREGATE**

**f.1.** Each of the two groups of beams tested in flexure at 60 days and 365 days shall have an average modulus of rupture of not less than 550 psi.

**f.2.** Expansion of beams:

**f.2.a.** At 180 days, the increase in length shall not exceed 0.050%.

**f.2.b.** At 365 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

Page 1 of 3

Sample of Sand Gravel (Wetting Drying)

Laboratory No 22-1776  
 AWP No. \_\_\_\_\_  
 Date reported \_\_\_\_\_  
 Date received 2/21/2022

Spec. No. 2015 SS, Subsec. 1102 Qty Unlimited  
 Property of \_\_\_\_\_  
 Sample from \_\_\_\_\_  
 Submitted by J. Frantzen Topeka, KS  
 Ident. Marks \_\_\_\_\_

Project No. Wetting & Drying Co/Dt \_\_\_\_\_ Type \_\_\_\_\_

Contractor \_\_\_\_\_

TEST RESULTS

This material was tested in accordance with Article 1117 of the 2015 KDOT Standard Specifications using Type I/II cement.

MATERIALS:

Aggregate - MA-1

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Cement - Monarch type I/II, Lab. #XX-XXXX

AGGREGATE SIEVE ANALYSIS:

SIEVE ANALYSIS										
English	in.									
	(3/4)	(1/2)	(3/8)	(#4)	(#8)	(#16)	(#30)	(#50)	(#100)	(#200)
% Ret.	0	2	15	40	55	65	80	93	98	100

Agg. Specific Gravity, S.S.D. (Theo. Comb.) ----- 2.58  
 % Absorption (Theo. Comb.) ----- 1.46  
 -#200 Material (%) ----- 0.00

MIX DESIGN DATA:

Date Made ----- 2/15/2022  
 Cement, kg (lb) ----- 42.64 (94.00)  
 Water, kg (lb) ----- 21.74 (47.94)  
 Aggregate, kg (lb) ----- 253.14 (558.09)  
 Slump, mm (in) ----- 57.2 (2.25)  
 Time of slump after addition of water (min.) ----- 12:15

## Unit Weight:

Theoretical Air Free, kg/m<sup>3</sup> (lb/ft<sup>3</sup>) ----- 2380.8 (148.63)  
 Actual, kg/m<sup>3</sup> (lb/ft<sup>3</sup>) ----- 2325.2 (145.16)

## Air Content:

Gravimetric, % ----- 2.3  
 Rollameter, % ----- 3.5

Yield Cement Factor kg (lb) ----- 238.72 (526.29)  
 Water - Cement Ratio, kgs/kg (lbs/lb) ----- 0.51

TEST DATA:

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

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

A	5.37 (779)	4.90 (710)		
B	5.34 (775)	4.96 (720)		
D	5.57 (808)	5.47 (794)		

Avg. @ 60 days	5.43 (787)	5.11 (741)		
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C			0.027	
D			0.027	
E			0.027	

Avg. @ 179 days			0.027	109.31
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C	5.10 (740)	5.10 (740)	0.053	
E	4.81 (698)	4.73 (686)	0.040	
F	3.76 (546)	3.63 (526)	0.047	

Avg. @ 365 days			0.047	108.81
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4.56 (661)

4.49 (651)

Page 3 of 3

Laboratory No 22-1776

DISPOSITION:

This material meets the requirements of Article 1117 of the 2015 KDOT Standard Specifications and is approved for use under the requirements of Sub-Article 1102 (b) (1.1.3).

cc:

File (2 )

Reported by: \_\_\_\_\_.

Title: Engineer of Physical Tests.