
Test Procedure for

FREE MOISTURE AND WATER ABSORPTION IN AGGREGATE FOR CONCRETE



TxDOT Designation: Tex-409-A

Effective Date: August 1999

1. SCOPE

- 1.1 This test is a rapid procedure for field determining the percentage of free or surface moisture in both fine and coarse aggregate, and for determining the percentage of water absorption for coarse aggregate of less than saturated surface dry (SSD) condition. These percentages are intended for use in correcting the batch weights for portland cement concrete.
- 1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.
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2. DEFINITIONS

- 2.1 *Free (Surface) Moisture*—moisture in excess of that required for saturated surface dry (SSD) condition in aggregate.
- 2.2 *Water Absorption*—percent of water necessary to add to the aggregate to obtain SSD condition.
- 2.3 *Wet Aggregate*—aggregate in the stockpile condition.
- Note 1**—Free moisture and water absorption are calculated percentages based upon the original weight of the aggregate (stockpile condition).
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PART I—DETERMINING FREE MOISTURE

3. SCOPE

- 3.1 Use this part to determine the percentage of free or surface moisture in both fine and coarse aggregate.
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4. APPARATUS

- 4.1 *Balance*, Class G2 in accordance with Tex-901-K, minimum capacity of 2000 g.
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4.2 Pycnometer, calibrated in accordance with Tex-403-A, Section 6.

4.3 Towel or lint-free cloth.

5. PROCEDURE

5.1 Determine the SSD specific gravity in accordance with Tex-403-A.

5.2 Obtain approximately 1500 g of coarse aggregate, or 1200 g of fine aggregate, in stockpile moisture condition. Weigh the wet aggregate and record the mass to the nearest 0.5 g as X under Section 6.

5.3 Place the wet aggregate in the pycnometer and fill with water at the same temperature as used to calibrate the pycnometer.

5.4 Remove all entrapped air from the pycnometer using one of the procedures outlined in Tex-403-A.

5.4.1 For fine aggregate, use Sections 6.2.17–6.2.21.

5.4.2 For coarse aggregate, use Sections 6.3.11–6.3.12.

5.5 Dry the outside of the pycnometer and completely fill it with water.

5.6 Determine the weight of the pycnometer and contents and record the mass to the nearest 0.5 g as Z_1 under Section 6.

6. CALCULATIONS

6.1 Calculate the mass of the pycnometer, containing sample in SSD condition with water to fill (Z):

$$Z = Y + X - (X / G)$$

6.2 Calculate Percent of Free Moisture based on the wet mass of the sample (M):

$$M = [100 \bullet G(Z - Z_1)] / [X(G - 1)]$$

6.3 Convert the wet mass to the SSD mass:

$$SSD\ Mass = X(100 - M) / 100$$

6.4 Back-calculate the amount of wet aggregate to yield a desired amount of SSD aggregate (W_s):

$$A = 100 \bullet W_s / (100 - M)$$

Where:

X = mass of the wet sample, g

Z_1 = mass of the pycnometer containing wet sample and water, g

G = saturated surface-dry specific gravity

Y = mass of pycnometer filled with water (calibration), g.

Note 2—It is not necessary to weigh out a definite quantity of wet aggregate when the percentage of free moisture is calculated from the formula. However, the values shown in Table 1 are applicable only when the wet weight of aggregate is between 1000 or 2000 ± 5 g, and the SSD specific gravity falls in the range of 2.58 to 2.72. The average SSD specific gravity of 2.65 was used in calculating the values in Table 1.

7. REPORTING TEST RESULTS

7.1 Report the Percent of Free Moisture to the nearest 0.1%.

PART II—WATER ABSORPTION IN COARSE AGGREGATE

8. SCOPE

8.1 Use this part to determine the percentage of water absorption for coarse aggregate.

9. APPARATUS

9.1 *Balance*, Class G2 in accordance with Tex-901-K, minimum capacity of 4000 g.

9.2 *Pan*, approximately 305 mm (12 in.) in diameter.

9.3 *Towel or lint-free cloth*.

10. PROCEDURE

10.1 Secure a representative sample of approximately 2000 g of coarse aggregate drier than the SSD condition.

10.2 Clean the aggregate thoroughly by rolling it in a dry towel or cloth and blowing away the dust and fine particles. This eliminates the major portion of the very fine material, an excess of which either introduces considerable error into the test results or renders the testing procedure difficult and laborious.

10.3 Weigh the sample to the nearest gram and record as X under Section 11.

10.4 Place the weighed sample in a pan and cover completely with water. Let stand for a minimum of 30 minutes.

- 10.5 Drain the water from the sample and dry the aggregate to the SSD condition in accordance with Tex-403-A.
- 10.6 Weigh the SSD sample to the nearest gram and record as X_I under Section 11.

11. CALCULATIONS

- 11.1 Calculate the Percent Water Absorption (A) based on the original mass of the sample:

$$A = 100(X_I - X) / X$$

Where:

X = mass of sample in stockpile condition

X_I = mass of sample in SSD condition.

- 11.2 Table 2 may be used with an original sample mass, X , of 2000 ± 5 g.

12. REPORTING TEST RESULTS

- 12.1 Report water absorption or free moisture to the nearest 0.1%.

Note 3—This procedure is intended for field use with normal concrete aggregates and is not applicable for use with manufactured lightweight aggregate.

Note 4—Since graniteware pans of 254 mm and 305 mm (10 in. and 12 in.) diameter are no longer readily available, any pan of suitable size and texture will be satisfactory. Avoid the use of metal pans that react with aggregates.

Table 1—Percent of Free Moisture

Free Moisture % Z-Z ₁ 1000 g 2000 g			Free Moisture % Z-Z ₁ 1000 g 2000 g			Free Moisture % Z-Z ₁ 1000 g 2000 g		
Grams	Sample	Sample	Grams	Sample	Sample	Grams	Sample	Sample
1	0.2	0.1	9	1.4	0.7	17	2.7	1.4
2	0.3	0.2	10	1.6	0.8	18	2.9	1.4
3	0.5	0.2	11	1.8	0.9	19	3.0	1.5
4	0.6	0.4	12	1.9	1.0	20	3.2	1.6
5	0.8	0.4	13	2.1	1.0	21	3.4	1.7
6	1.0	0.5	14	2.3	1.1	22	3.5	1.8
7	1.1	0.6	15	2.4	1.2	23	3.7	1.8
8	1.3	0.6	16	2.6	1.3	24	3.9	1.9

Table 2—Percent Water Absorption

X₁-X (g)	% Moisture Absorbed						
1	0.05	26	1.30	51	2.55	76	3.80
2	0.10	27	1.35	52	2.60	77	3.85
3	0.15	28	1.40	53	2.65	78	3.90
4	0.20	29	1.45	54	2.70	79	3.95
5	0.25	30	1.50	55	2.75	80	4.00
6	0.30	31	1.55	56	2.80	81	4.05
7	0.35	32	1.60	57	2.85	82	4.10
8	0.40	33	1.65	58	2.90	83	4.15
9	0.45	34	1.70	59	2.95	84	4.20
10	0.50	35	1.75	60	3.00	85	4.25
11	0.55	36	1.80	61	3.05	86	4.30
12	0.60	37	1.85	62	3.10	87	4.35
13	0.65	38	1.90	63	3.15	88	4.40
14	0.70	39	1.95	64	3.20	89	4.45
15	0.75	40	2.00	65	3.25	90	4.50
16	0.80	41	2.05	66	3.30	91	4.55
17	0.85	42	2.10	67	3.35	92	4.60
18	0.90	43	2.15	68	3.40	93	4.65
19	0.95	44	2.20	69	3.45	94	4.70
20	1.00	45	2.25	70	3.50	95	4.75
21	1.05	46	2.30	71	3.55	96	4.80
22	1.10	47	2.35	72	3.60	97	4.85
23	1.15	48	2.40	73	3.65	98	4.90
24	1.20	49	2.45	74	3.70	99	4.95
25	1.25	50	2.50	75	3.75	100	5.00