T 288

DETERMINING MINIMUM LABORATORY SOIL RESISTIVITY FOP FOR AASHTO T 288

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Scope

This test method covers the laboratory determination for the minimum resistivity of a soil sample. The principal use of this test method is to determine a soil's corrosivity and thereby identify the conditions under which the corrosion of the metals in soil may be sharply accentuated.

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Sampling

Obtain a representative sample of sufficient size according to appropriate sampling requirements for soils. Reduce to an appropriate test sample size according to AASHTO T 248.

The original sample size must be sufficient to yield at least 1500 grams of dry material passing the No. 10 sieve.

Apparatus

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- **Balance:** The balance shall be of sufficient capacity and readable to 0.1 percent of the sample mass, conforming to AASHTO M 231.

- **Drying Apparatus:** Any suitable device capable of drying samples at a temperature not exceeding 140° F.
- **Sieves:** A series of the following sizes: 1/4 inch, No. 4, No.10 and a pan.

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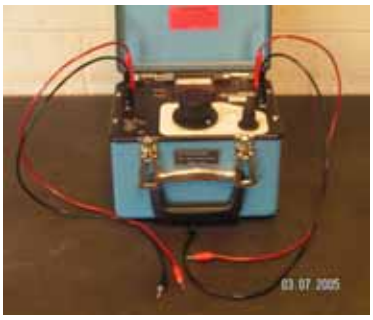
- **Pulverizing Apparatus:** Either mortar and rubber-covered pestle or any device suitable for breaking up the aggregations of soil particles without reducing the size of the individual grains of soil.



- **Sample Splitter:** A suitable riffle sampler or sample splitter for proportional splitting of the sample and capable of obtaining representative portions of the sample without appreciable loss of the fines. The width of the container used to feed the riffle sample splitter should be equal to the total width of the riffle chutes. Proportional splitting or quartering of the sample on canvas cloth is also permitted.

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- **Resistivity Meter:** An alternating current (AC) meter or a 12 volt direct current (DC) meter utilizing a Wien Bridge (AC bridge) with a

Note 1: Most resistance meters without an inverting circuit allow the sample under test to polarize during measurement causing the reading to vary.

phase sensitive detector and a square wave inverter that produces a nominal alternating signal at 97 Hz. (See Note 1)

- **Resistors:** 100, 200, 500, and 900 Ω resistors with a 1 percent tolerance. (Follow Manufacturer's guidelines.)
- **Soil Box:** The soil box is described in detail in the AASHTO standard.

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- **Mixing pans:** Manufactured from non-corrosive materials such as stainless steel or plastic.
- **Graduated Cylinder:** 100 mL capacity.
- **Distilled or Deionized Water:** Resistivity of the water shall be greater than 20,000 (ohm) x (cm).
- **Straight edge:** 12 inches in length, suitable for striking off sample even with the top of the soil box.

Sample Preparation

10 The sample as received from the field shall be dried in air or a drying apparatus not exceeding 140° F. The sample shall then be reduced to an appropriate size by splitting or quartering. The aggregations of soil particles shall then be broken up in the pulverizing apparatus.

The portion of the dried sample selected for testing shall be separated into fractions by one of the following methods:

Method A – Alternate method Using No. 10 Sieve

11 The dried sample shall be separated into two fractions using the No. 10 sieve. The fraction retained on the sieve shall be ground with a

12 pulverizing apparatus until the aggregations of soil particles are broken into separate grains. After pulverizing, that material shall be separated into two fractions over the No. 10 sieve.

The sample used for testing shall consist of all the material passing the No. 10 sieve after the separation procedure described above.

Method B – Alternate method Using No. 4 and No. 10 Sieves

13 The dried sample shall first be separated into two fractions using the No. 4 sieve. The fraction retained on this sieve shall be ground with a pulverizing apparatus until the aggregations of soil particles are broken into separate grains and again separated on the No. 4 sieve. The fraction passing the No. 4 sieve shall be mixed thoroughly and, by use of the splitter or by splitting and quartering, a representative portion adequate for testing shall be obtained. This split-off portion shall then be separated on the No. 10 sieve, and prepared according to Method A.

Method C – Alternate method Using 1/4 inch and
14 **No. 10 Sieves**

The dried sample shall first be separated into two fractions using the 1/4 in sieve. The fraction retained on this sieve shall be ground with a pulverizing apparatus until the aggregations of soil particles are broken into separate grains and again separated on the 1/4 in sieve. The fraction passing the 1/4 in sieve shall be mixed thoroughly and, by use of the splitter or by splitting and quartering, a representative portion adequate for testing shall be obtained. This split-off portion shall then be separated on the No. 10 sieve, and prepared according to Method A.

15 ## Minimum Soil Resistivity Determination

This part of the test method covers the laboratory procedure for determining the minimum resistivity of the soil sample. The values obtained from this method are relatable to the corrosion potential that a soil may exhibit

16 **Calibration of Resistivity Meter**

Calibrate the resistivity meter using the following procedure, or follow manufacturer instructions for calibration:

- Zero the meter by clamping the two leads together, and adjusting the meter as necessary.
- Connect the leads of the meter to the 100 Ω resistor and read the meter.
- Repeat the process with the 200, 500, and 900 Ω resistors.

- If the resistance meter readings are within 10 percent of that of the resistor, the meter is functioning satisfactorily.

Soil Resistivity Determination

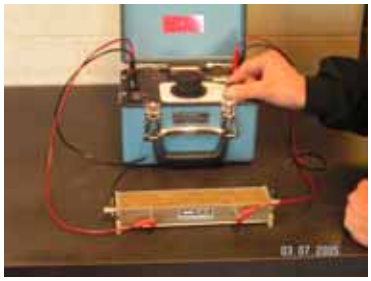
17 1. From the prepared material, obtain a representative test sample of approximately 1500 grams according to AASHTO T 248.

2. Add 150 mL of distilled water to the prepared soil. Mix the sample thoroughly and cover the test sample to stabilize until equilibrium has been reached, or allow curing for a minimum of 12 hours.

18 3. Zero the meter per the manufacturer's instructions. Clean the soil box thoroughly with
19 distilled water.

4. Thoroughly mix and place the sample in the soil box in layers and compact (moderate compaction with fingers is adequate). Trim off excess material with straight edge.

5. Measure the resistance and calculate the
20 resistivity of the soil in accordance with the instructions furnished with the meter and record the test value.



21 6. Remove and retain the soil from the soil box, add 100 mL of distilled water to the sample and mix thoroughly. Clean the soil box thoroughly with distilled water prior to performing the next test. Repeat the process of compacting the soil in the box, then measure the resistance and calculate the soil resistivity.

Note 2: The minimum resistivity can occur at any moisture content. In some soils the minimum soil resistivity occurs when the specimen is a slurry.

22 7. Repeat the previous 4 steps until a minimum value can be determined. The minimum value is used for computing the minimum soil resistivity and reporting.

Calculation

23 Calculate minimum soil resistivity (**R**) according to the following formula:

R = Minimum Reading (Ω) x Multiplying Constant

The multiplying constant is derived as follows:

$$\frac{\text{Surface Area of One Electrode (cm}^2\text{)}}{\text{Measured Avg. Distance Between Electrodes (cm)}}$$

24 For the typical AASHTO T 288 soil box, the multiplying constant is:

$$\frac{15.24\text{ cm} \times 4.445\text{ cm}}{10.16\text{ cm}} = 6.67\text{ cm}$$

Calculation Examples

Critical Dimensions: 25

Electrode Width: 4.440 cm
Electrode Length: 15.22 cm
Average Measured Distance Between Electrodes: 10.18 cm

Multiplying Factor: $\frac{15.22\text{ cm} \times 4.440\text{ cm}}{10.18\text{ cm}} = 6.64\text{ cm}$

Minimum Measured Resistance: 720 Ω 26

Minimum Soil Resistivity (R): 720 x 6.64 = 4781 (ohm) x (cm)

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Report

- Report on standard agency forms.
- Report minimum soil resistivity in units of (ohm) x (cm).

Tips! 28

- Be sure the sample is of sufficient size to yield at least 1500 g of material passing the No. 10 sieve.
- The sample used for testing consists of **all** the material that will pass the No. 10 sieve after processing according to methods A, B, or C.
- Remember that minimum soil resistivity may occur at any moisture content.

REVIEW QUESTIONS

1. Why is this test performed?

2. Describe the initial sample preparation.

3. How is the resistivity meter calibrated?

4. Describe the soil resistivity determination.

5. Given the following, calculate the multiplying factor:

   Electrode length: 15.27 cm
   Electrode width: 4.440 cm
   Average Measured Distance Between Electrodes: 10.22 cm

6. Using the multiplying factor calculated above, what is the minimum soil resistivity when the resistance values of the soil at various moisture contents are as follows:

Test No.	Measured Resistance
1	2120 Ω
2	1860 Ω
3	930 Ω
4	640 Ω
5	1210 Ω

PERFORMANCE EXAM CHECKLIST

DETERMINING MINIMUM LABORATORY SOIL RESISTIVITY FOP FOR AASHTO T 288

Participant Name:_____ Exam Date:_____

Procedure

Sampling

1. Sample obtained by method approved by agency for sampling of soils? _____
2. Sample reduced to appropriate size according to AASHTO T 248? _____
3. Sample large enough to yield at least 1500 grams of dry soil finer than No. 10 sieve after processing? _____

Sample Preparation

1. Sample air-dried or oven-dried at a temperature not exceeding 140° F? _____
2. Specimen separated by appropriate method (A, B, or C)? _____
3. A representative sample (approximately 1500 g) finer than No. 10 sieve obtained by T 248? _____

Procedure

1. 150 ml of distilled water added to 1500 g sample? _____
2. Non-corrosive pan used for mixing? _____
3. Sample thoroughly mixed, covered and allowed to cure at least 12 hours? _____
4. Meter zeroed? _____
5. Box clean (using only distilled water)? _____
6. Sample mixed and placed in box in layers and moderately compacted? _____
7. Excess material trimmed from surface using straightedge? _____
8. Resistance measured, calculated and recorded? _____
9. Soil removed from box, 100 mL distilled water added? _____
10. Steps 4 – 9 repeated until a minimum value can be determined? _____
11. Calculation performed correctly? _____

Comments: First attempt: (Pass/Fail) ___ Second attempt: (Pass/Fail) ___

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Signature of Examiner_____.