DETERMINING pH AND MINIMUM RESISTIVITY OF SOILS AND AGGREGATES

(An Arizona Method)

1. SCOPE

1.1 This test method outlines the procedure for determining the pH and minimum resistivity of soil and aggregate materials.

1.2 This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

1.3 See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

2.1 Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual.

2.2 Drying Apparatus - Any suitable device capable of drying samples at a temperature not exceeding 140 °F.

2.3 100 mL glass beaker or other suitable non-metallic container.

2.4 200 mL minimum capacity cylinder graduated in 1 mL increments.

2.5 Distilled Water.

2.6 pH Meter and combination probe, both having a relative accuracy of $\pm$ 0.05 pH units, minimum. The pH meter must be capable of registering a minimum pH range of 4.0 - 10.0, and be equipped with temperature compensation controls.

2.7 Standard Buffer Solutions of pH values 4.0, 7.0, and 10.0. The expiration date of the solution shall be noted on the container. Solution shall not be used past the expiration date.

2.8 Soil Box - Designed for use with the resistance meter. An example of an acceptable soil box is shown in Figure 1. Soil boxes which are commercially available may be used provided they meet the requirements specified herein. Soil boxes may vary in size. A unique soil box factor is determined for each soil box.

2.9 Resistance Meter - Instrument to determine resistance (ohms), readable to at least the nearest 10 ohms.

Note: The accuracy of the meter shall be established at these measurement levels: 50, 100, 200, 500, 900, 1500 ohms. The resistance standard(s) will have a tolerance of ± 1%. Any deviation greater than 5% from the known resistance shall require either calibration to within specified limits or the development of a calibration curve. Calibration results shall be recorded, dated, signed, and maintained on file for review.

2.10 No. 8 sieve conforming to AASHTO Designation M 92.

2.11 A Balance or Scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.1 gram.

2.12 Thermometer - A thermometer accurate to 1 °F.

2.13 Miscellaneous mixing tools and pans.

3. SAMPLE PREPARATION

3.1 The soil sample as received from the field shall be dried thoroughly in air or the drying apparatus at a temperature not exceeding 140 °F.

3.2 A representative test sample of approximately 2000 grams shall then be obtained by splitting or quartering.

3.3 Screen the test sample through a No. 8 sieve.

3.4 From the screened Pass No. 8 Material, split out approximately 1500 grams for the resistivity test and obtain approximately 50 grams for the pH test. Record the weight of the pH material to the nearest 0.1 gram.

3.5 Combine the pH sample with an equal weight of distilled water in the 100 mL beaker. Stir until well mixed into a slurry and then stir at regular intervals of 8 to 10 minutes for an hour.

3.6 The temperature of the standard buffer solutions must be within 2 °F of the pH sample. Also, temperatures of the standard buffer solutions and the pH sample must be within the manufacturer's recommended temperature compensation range of the pH meter.

3.7 Place the resistivity sample in a mixing bowl. Add approximately 200 mL of distilled water to moisten the sample and mix thoroughly.

4. TEST PROCEDURE FOR pH

4.1 Per the manufacturer's instructions, standardize the pH meter using two of the standard buffer solutions: 7.0 and either 4.0 or 10.0, <u>whichever is nearest to the estimated pH of the sample</u>.

4.2 For <u>each</u> standard buffer solution, measure its temperature and adjust the temperature controller of the pH meter <u>before</u> testing for the standard solution pH value. This may not be needed on meters with automatic temperature compensation; follow manufacturer's instructions.

4.3 Stir the slurry mixture in the 100 mL beaker. Measure the temperature of the slurry and adjust the temperature controller of the pH meter <u>before</u> testing for the pH value of the slurry. This may not be needed on meters with automatic temperature compensation; follow manufacturer's instructions.

4.4 Carefully insert the pH probe in the slurry mixture. Do not place the electrode(s) into the soil; place them only into the slurry mixture. Determine the pH reading when the meter reading stabilizes.

4.5 If the pH reading is unstable when the electrode is immersed in the slurry, leave the electrode immersed until the pH reading has stabilized. In some cases, the waiting period for stabilization of the pH reading may take up to 5 minutes.

4.6 Record the pH value of the slurry mixture, to the nearest tenth.

5. TEST PROCEDURE FOR MINIMUM RESISTIVITY

5.1 Place moistened soil in a soil box with a known soil box factor, compact lightly with fingers and level off the top with a straightedge. Connect the resistance meter to the side terminals of the box. Determine resistance as per the manufacturer's instructions and record the resistance to the nearest 10 ohms.

5.2 Empty the soil back into the mixing bowl and add 50 mL of distilled water at room temperature and mix until all the water is dispersed uniformly through the soil.

5.3 Clean the soil box by rinsing with distilled water after each test application.

5.4 Fill the soil box by lightly hand compacting the wet soil, making sure that the soil completely fills the box. Level off the top of the hand compacted sample with a straightedge. Connect the resistance meter to the box. Read and record the resistance.

5.5 Repeat the above procedure, adding distilled water in increments of 50 mL. Ensure that each addition of water is dispersed evenly through the sample. The resistance readings should decrease, with the increase in moisture content, for several readings before an increase is noted. The lowest resistance reading before an increase is used for calculating the minimum resistivity of the soil.

6. CALCULATIONS FOR MINIMUM RESISTIVITY

6.1 Determine the length and width of the electrodes to the nearest 1 mm.

6.2 The soil box factor (SBF) expressed to the nearest 0.01 centimeter, is determined by the following equation:

$$\text{SBF} = \frac{A}{D} \times 0.10$$

Where: A = Area of one electrode, mm^2
D = Distance between electrodes, mm

Example: (For electrodes having a length of 152 mm and a width of 45 mm, and at a distance between electrodes of 102 mm.)

A = 152 mm x 45 mm = 6840 mm^2
D = 102 mm

$$\text{SBF} = \frac{6840}{102} \text{ x } 0.10 = 6.71 \text{ cm}$$

Note: The soil box factor will depend on the soil box dimensions.

6.3 The minimum resistivity is determined by the following equation:

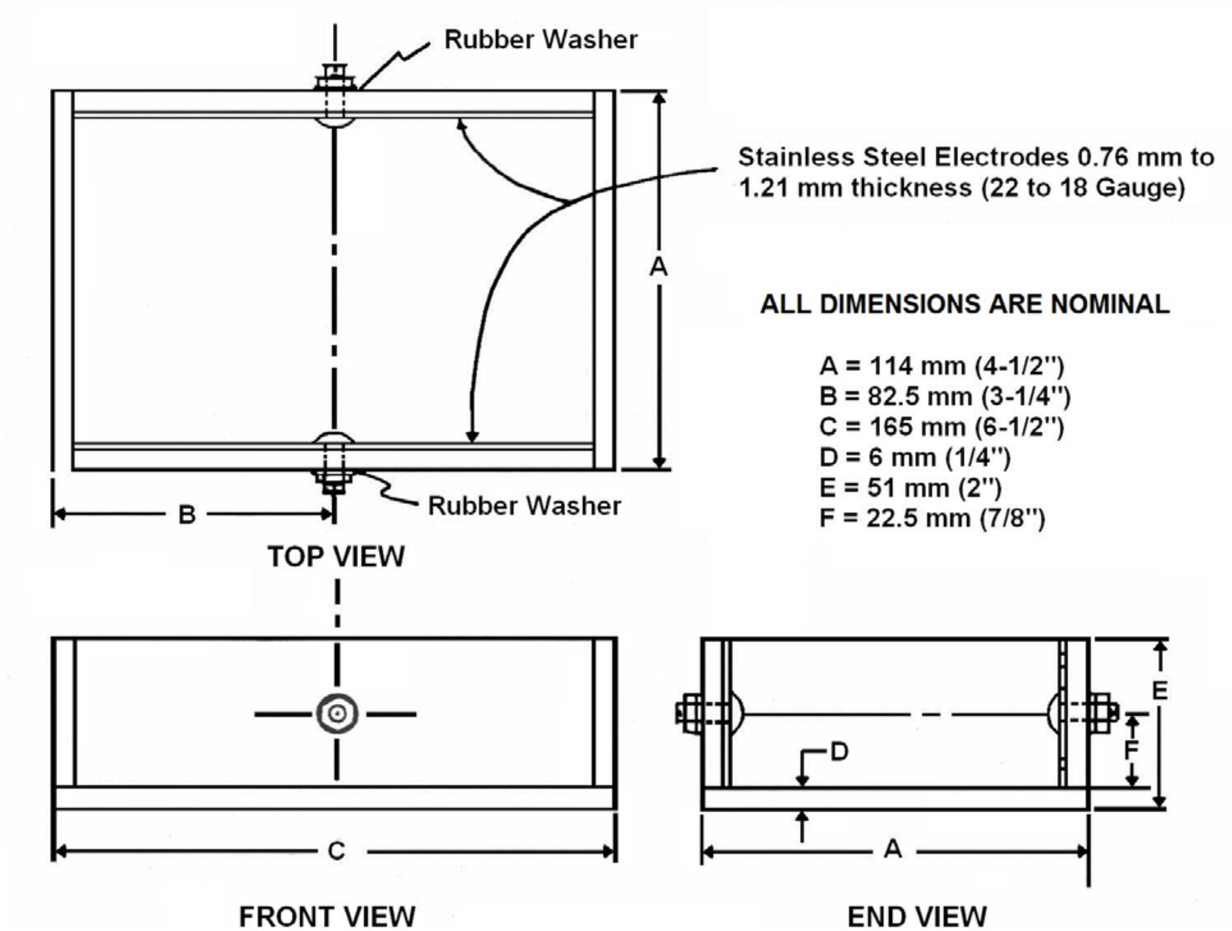
$$\begin{bmatrix} \text{Minimum Resistivity} \\ \text{(ohm-cm)} \end{bmatrix} = \begin{bmatrix} \text{Resistance} \\ \text{(ohms)} \end{bmatrix} \text{ x } \begin{bmatrix} \text{SBF} \\ \text{(cm)} \end{bmatrix}$$

Example: (For a resistance reading of 480 ohms and a soil box factor of 6.71 cm.)

Minimum Resistivity = (480 ohms) x (6.71 cm)
= 3220.8 ohm-cm
= 3221 ohm-cm

6.4 The minimum resistivity value is reported to the nearest whole number.

EXAMPLE OF AN ACCEPTABLE SOIL BOX



Box Material [6 mm (1/4") Plastic]

Bottom - 1 piece: 165 mm x 114 mm x 6mm (6-1/2" x 4-1/2" x 1/4")
Ends - 2 pieces: 114 mm x 45 mm x 6 mm (4-1/2" x 1-3/4" x 1/4")
Sides - 2 pieces: 152 mm x 45 mm x 6 mm (6" x 1-3/4" x 1/4")

Electrodes [0.76 mm to 1.21 mm thickness (22 to 18 Gauge) Stainless Steel]
2 pieces: 152 mm x 45 mm (6" x 1-3/4")

Hardware - 2 each No. 8-32 x ¾" (or longer), or metric equivalent, Stainless Steel or Brass Machine Screw with Washer and Nut

Gasket - Rubber Washer

FIGURE 1