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ENGINEERING SERVICE CENTER
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METHOD OF TEST FOR SPECIFIC GRAVITY OF SOILS

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read “**SAFETY AND HEALTH**” in Section H of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

This method of test, which is a modification of AASHTO Designation T 100, is used for the determination of the specific gravity of soils by means of a pycnometer.

When the soil contains particles retained on the 4.75 mm sieve, the sample shall be separated on the 4.75 mm sieve and the *apparent* specific gravity of the retained 4.75 mm sieve material shall be determined in accordance with California Test 206. The specific gravity of the passing 4.75 mm portion shall be determined by the method herein described. The specific gravity value for the soil shall be the weighted average of the two values.

B. APPARATUS

1. Pycnometer. One of the following:
 - a. Volumetric flask having a capacity of 500 ml.
 - b. Volumetric flask having a capacity of 100 ml.
 - c. A stoppered bottle having a capacity of 50 ml. The bottle stopper shall be of the same material as the bottle, and shall be capable of being easily inserted to a fixed depth in

the neck of the bottle, and shall have a small hole through its center to permit the emission of air and surplus water.

The use of either the volumetric flasks or the stoppered bottle is a matter of individual preference, but in general, a flask should be used when a larger sample than can be used in the stoppered bottle is needed due to maximum grain size of the sample.

2. Balance: Either a balance sensitive to 0.01 g for use with the 100 ml and 500 ml volumetric flasks, or a balance sensitive to 0.001 g for use with the 50 ml stoppered bottle.
3. Thermometer sensitive to 1°C.

C. CONTROL

The temperatures of the pycnometer contents at the two weighings shall be $20 \pm 5^\circ\text{C}$, and these temperatures designated at T_i and T_x shall not differ by more than 5°C.

Alternate: If it is desired to perform the test at temperatures outside the above specified range, corrections for differences in temperature shall be applied as provided in AASHTO Designation T 100.

D. CALIBRATION OF PYCNOMETER

Clean and dry the pycnometer, then determine and record its mass in grams. Fill the pycnometer with distilled water having a temperature of $20 \pm 5^\circ\text{C}$. Determine and record the mass in grams, W_a , of the pycnometer and water. Insert the thermometer in the water and read and record the temperature, T_i , to the nearest whole degree Celsius.

NOTE: Kerosene is a better wetting agent than water for most soils and may be used in place of distilled water for *oven-dried* samples.

E. SAMPLE PREPARATION

1. The soil to be used in the specific gravity test may contain its natural moisture or be oven-dried. The mass of the test sample on an oven-dry basis shall be at least 125 g when the 500 ml flask is to be used, at least 25 g when the 100 ml flask is to be used, and at least 10 g when the 50 ml stoppered bottle is to be used.
2. Samples containing natural moisture:
 - a. When the sample contains its natural moisture, determine the mass of the soil, W_o , on an oven-dry basis at the end of the test by evaporating the water from the sample in an oven maintained at 110°C . Drying of certain soils at 110°C may bring about loss of moisture or composition or hydration, and in such cases, drying shall be done, if desired, in reduced air pressure and at a lower temperature.
 - b. *Disperse samples of clay soils containing their natural moisture content* in distilled water before placing in the flask, using the mechanically operated stirring apparatus specified in the Standard Method of Mechanical Analysis, AASHTO Designation T- 88.
3. Oven-dried samples: When an oven-dried sample is to be used, dry the sample for at least 12 hours, or to constant mass, in an oven maintained at 110°C . However, a lower temperature may be permitted for certain soils as explained in 2a above. Cool the sample in a desiccator and determine the mass upon removal from the desiccator. Then soak the sample for at least 12 hours in distilled water.

F. TEST PROCEDURE

1. Place the test sample in the pycnometer, taking care not to lose any of the soil in case the oven-dry mass has been determined. Add distilled water to the flask until it is about three-fourths full or to the stoppered bottle until it is about half full.
2. Remove entrapped air by either of the following methods:
 - a. Subject the contents to a partial vacuum (air pressure not exceeding 100 mm of mercury).
 - b. Gently boil the contents for at least 10 minutes while occasionally rolling the pycnometer to assist in the removal of air.
3. Subjection of the contents to reduced air pressure may be done either by connecting the pycnometer directly to an aspirator or vacuum pump, or by use of a bell jar. Some soils boil violently when subjected to reduced air pressure. It will be necessary in those cases to reduce the air pressure at a slower rate or to use a larger flask. Samples that are heated shall be cooled to approximately 20°C .
4. After the air has been removed, fill the pycnometer with distilled water and bring the temperature of the total contents to $20 \pm 5^\circ\text{C}$ and within 5°C of temperature T_i by use of a water bath or other suitable means. Clean and dry the outside of the pycnometer with a clean, dry cloth. Determine and record the mass in grams of the pycnometer and contents, W_b , and the temperature in degrees Celsius, T_x , of the contents.
5. If the test was performed on a test sample which contained its natural moisture, determine the dry mass of the material by evaporating off the water in an oven maintained at 110°C , or at a lower temperature as explained under E-2, until the material reaches a constant mass. Cool the sample to room temperature, determine the mass in grams and record the mass, W_o .

G. CALCULATIONS

1. Calculate the specific gravity of the soil as follows:

$$\text{Specific gravity} = W_o / (W_o + W_a - W_b)$$

Where:

W_o = Mass in grams of sample of oven dry soil

W_a = Mass in grams of pycnometer filled with water at temperature T_i

W_b = Mass in grams of pycnometer filled with water and soil at temperature T_x

2. To obtain the specific gravity of soils which contain both retained and passing 4.75 mm material and are therefore separated and tested separately, compute the specific gravity for the whole soil by weighted averages as follows:

$$\text{Specific gravity of soil} = (P_f \times G_f + P_c \times G_c) / 100$$

Where:

P_f = percent of passing 4.75 mm sieve fraction by oven-dry mass,

P_c = percent of retained 4.75 mm sieve fraction by oven-dry mass,

G_f = specific gravity of the passing 4.75 mm sieve fraction, and

G_c = specific gravity of the retained 4.75 mm sieve fraction.

H. SAFETY AND HEALTH

Soils and waters may contain bacteria and/or organisms which can be harmful to one's health. Please be sure to clearly identify those soils and waters which may contain contaminants. The wearing of dust masks and protective gloves when handling materials is advised.

If boiling off air from soil suspension, use caution when handling hot flasks (pycnometer) and beware of steam emanating from the mouth of a

pycnometer while water is boiling. The use of tongs or heat resistant gloves is recommended.

If using the vacuum alternative to remove air, use approved vacuum chamber that will withstand required low pressures.

This method does not purport to address all the safety problems associated with its use.

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans' Laboratory Safety Manual.

Users of this method do so at their own risk.

REFERENCES:
AASHTO Designations T 88 and T 100
California Test 206
End of Test (3 Pages) on California Test 209