

Australian Standard™

Methods of testing soils for engineering purposes

Method 3.5.1: Soil classification tests— Determination of the soil particle density of a soil—Standard method

1 SCOPE

This Standard sets out the method for determining soil particle density by using a density bottle for the fine fraction of a soil and by weighing in water for soil particles retained on a 2.36 mm sieve. The soil particle density of the soil is the weighted average of the two values.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1152	Specification for test sieves
1289	Methods of testing soils for engineering purposes
1289.0	Part 0: General requirements and list of methods
1289.1.1	Method 1.1: Sampling and preparation of soils—Preparation of disturbed soil samples for testing
1289.2.1.1	Method 2.1.1: Soil moisture content tests—Determination of the moisture content of a soil—Oven drying method (standard method)

3 APPARATUS

The following apparatus is required:

- Density bottle of approximately 250 mL capacity.
- Desiccator.
- Drying oven complying with AS 1289.0, thermostatically controlled to operate at 105°C to 110°C.
- Balance with a limit of performance not exceeding ± 0.05 g.
- Balance with a limit of performance not exceeding ± 1 g.
- Thermometer to cover the range 0°C to 100°C, graduated to 1°C and with an uncertainty not exceeding 0.5°C.
- A 2.36 mm sieve and pan as designated in AS 1152.
- Means of obtaining a vacuum (e.g., a filter or vacuum pump).

- (i) Distilled, demineralized or deionized water.

NOTE: With certain soils (e.g., those containing water soluble salts) kerosene or other liquid may be preferred. Where an alternative to water has been used, report the liquid used and determine its density at the temperature of the test by a separate experiment. Equation 6.3 for the soil particle density then becomes—

$$\rho_s = \frac{\rho_L (m_2 - m_1)}{(m_4 - m_1) - (m_3 - m_2)}$$

where

ρ_s = soil particle density of the fraction passing the 2.36 mm sieve, in grams per cubic centimetre

ρ_L = density of the liquid used, at the constant temperature, in grams per cubic centimetre

m_2 = mass of bottle plus stopper and dry soil particles, in grams

m_1 = mass of density bottle plus stopper in grams

m_4 = mass of bottle when full of liquid only, in grams

m_3 = mass of bottle, soil particles and liquid, in grams

- (j) Wash bottle containing water.
- (k) Wash bottle containing acetone or alcohol.
- (l) Water bath to control temperature variations, or a constant temperature room (optional).
- (m) Wire basket of appropriate mesh and size or similar device for holding the sample.
- (n) Container for water of appropriate size and shape to accommodate the basket, and fitted with an overflow pipe so that the water will be maintained at constant level.
- (o) Suitable apparatus for suspending the basket from the hook, or device supporting the scale pan of the balance.

4 PREPARATION OF SAMPLE

The sample shall be prepared in accordance with the appropriate requirements of AS 1289.1.1. Using a 2.36 mm sieve, the fraction of material retained on the sieve shall be separated from that passing the sieve.

5 PROCEDURES

5.1 Soil particle density of fraction passing the 2.36 mm sieve

The balance described in Clause 3(d) shall be used for determining mass in this Section. The procedure shall be as follows:

- (a) Completely wash the density bottle with water, rinse several times with acetone or alcohol and dry by blowing air into the bottle. Determine the mass of the bottle plus stopper (m_1).
- (b) By riffing or quartering the material passing the 2.36 mm sieve, obtain a subsample that will occupy about one-third of the volume of the density bottle. Transfer the soil particles to the density bottle.
- (c) Add water to fill the bottle approximately two-thirds full and allow the soil particles to soak for about 24 h.

- (d) Gradually apply a partial vacuum to the bottle (air pressure not exceeding 13 kPa) and maintain the vacuum for at least 10 min, occasionally rolling the bottle to assist in the removal of entrapped air. During this operation, take care to ensure that any air trapped in the soil does not bubble too violently, otherwise small drops of the suspension might be lost through the mouth of the bottle.
- (e) Fill the bottle with water and allow time for it and the water to establish a thermal equilibrium with the water-bath or room. During this period—
 - (i) add water as necessary to maintain the water level;
 - (ii) insert the stopper;
 - (iii) dry the outside of the bottle;
 - (iv) determine the mass of the bottle plus stopper and contents (m_3); and
 - (v) measure the temperature of the contents to within 1°C.
- (f) Remove the soil from the bottle and place it in a dish, taking care not to lose any particles.
- (g) Dry the soil in an oven at 105°C to 110°C to constant mass (see AS 1289.2.1.1). Determine the mass (m_1) of dry soil.
- (h) Fill the bottle with water and allow time for it and the water to reach within $\pm 2^\circ\text{C}$ the equilibrium temperature established in Step (e). During this period—
 - (i) add water as necessary to maintain the water level;
 - (ii) insert the stopper;
 - (iii) dry the outside of the bottle; and
 - (iv) determine the mass of the bottle plus stopper plus water (m_4).
- (i) Repeat the procedure using a separate subsample.

5.2 Soil particle density of fraction retained on the 2.36 mm sieve

The balance described in Clause 3(e) shall be used for determining mass in this procedure. The procedure shall be as follows:

- (a) Obtain a subsample of approximately 5 kg by riffing or quartering the material retained on the 2.36 mm sieve.
- (b) Thoroughly wash the subsample to remove dust and other coatings from the surface of the particles.
- (c) Immerse the subsample in water at room temperature for a period of 24 h.
- (d) Determine the equivalent mass of the wire basket immersed in water (m_6).
 NOTE: With some direct reading balances a small error may be introduced when determining the equivalent *mass of the basket under water*. This will be caused by the movement of the arm of the beam creating a variation in the depth of the immersion of the wires supporting the basket. For the purposes of this Standard, the equivalent mass of an object is defined as that mass which, in air, produces the same gravitational force as the object in question when immersed in water.
- (e) Place the saturated subsample in the wire basket, jiggle the material to remove any entrapped air and determine its equivalent mass in water to within 0.5 g (m_7). Measure the temperature of the water to 1°C.
- (f) Place the subsample in a dish, drain off free water and place the dish plus subsample in the drying oven.