



Test method T129

Particle density and water absorption of the fine sand fraction of soils

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Revision Summary

Ed/Rev Number	Clause Number	Description of Revision	Authorisation	Date
		Reformatted and Revision Summary Added	D.Dash	May 1999
		Date on Test Method Revised to Agree with Date on Revision	D.Dash	Feb 2001
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Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T129 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T129

Particle density and water absorption of the fine sand fraction of soils

1. Scope

This method sets out the procedure for the determination of the particle density and water absorption of the sand-silt fraction of soils. For this test the upper size limit of sand particles is taken as 2.36 mm and the lower size limit for silt particles is taken as 13.5 μm .

The Density and Water Absorption of the fractions coarser than 2.36 mm can be determined using Test Methods T209 and T210.

This test method is a modification of the method set out in Australian Standard 1141.

2. Definitions

Term	Definition
Particle Density	The mass in the air of the oven dry particles divided by the saturated but surface dry volume of the particles (i.e. the gross volume which includes both permeable and impermeable voids).
Particle Density on a saturated surface dry basis	The mass in air of the saturated but surface dry particles divided by the saturated but surface dry volume of the particles.

3. Apparatus

- (a) 19.0 mm, 9.50 mm, 4.75 mm, 2.36 mm, 425 μm , and 75 μm AS sieves.
- (b) A balance with a limit of performance of 0.5 g
- (c) Metal dishes, approximately 100 mm, 225 mm and 350 mm diameter.
- (d) A metal mixing and quartering tray
- (e) Mixing apparatus such as a trowel and spatula, and quartering apparatus such as metal plates 400 mm by 125 mm and 200 mm by 125 mm
- (f) Sieve brushes.
- (g) A porcelain mortar with porcelain and rubber pestles.
- (h) = Sample dividers (riffle boxes) of appropriate size openings (optional)
- (i) A thermostatically controlled oven with good air circulation, capable of maintaining a temperature not exceeding 50°C
- (j) A thermostatically controlled oven with good air circulation, capable of maintaining a temperature within the range of 105°C to 110°C
- (k) Pyrex beakers, squat form, 1 litre capacity, with lip and pouring spout. Graduation marks are to be made on the side of each beaker to indicate levels 30 mm and 110 mm above the base of the beaker.
- (l) Rubber-tipped glass stirring rods.
- (m) A timing device indicating in seconds and minutes
- (n) A thermometer indicating within the range 0-100°C
- (o) A bench type sieve shaking machine (optional).
- (p) A decantation bench
- (q) A heating device with rapidly adjustable temperature agent

- (r) A dispensing device for the dispersing agent
- (s) A 20% ammonia solution
- (t) Watch-glass, approximately 100 mm diameter
- (u) Desiccator preferably cabinet type
- (v) A constant temperature water bath having a depth of approximately 150 mm thermostatically controlled to maintain a temperature of $25 \pm 1^\circ\text{C}$
- (w) A 500 mL volumetric flask
- (x) A rigid metal conical mould 38 ± 3 mm diameter at the top, 90 ± 3 mm diameter at the bottom and 73 ± 3 mm high.
- (y) A metal tamping rod with a mass of 350 g having a flat circular tamping face approximately 25 mm in diameter

4. Preparation

- (a) Allow the sample to dry sufficiently to enable it to be crumbled. If necessary, dry the sample in an oven at a temperature not exceeding 50°C .
- (b) Break up any aggregations of particles in such a way as to avoid crushing any discrete particles. All aggregations are to be broken down so that if the sample was screened on a 2.36 mm AS sieve, only discrete uncrushed particles would be retained. A rubber pestle should be used to avoid breaking down sound pieces of mineral matter. Adhering material should be brushed from the coarse particles. When in doubt as to whether lumps are to be broken, place some in water and boil. If slaking occurs, the material should be broken further with the rubber pestle.
- (c) Screen the sample on a 2.36 mm AS sieve. To facilitate this operation and to avoid overloading of sieves, screen the sample on 19.0 mm, 9.50 mm and 4.75 mm AS sieves prior to separation on 2.36 mm AS sieve.
- (d) Dry the material passing the 2.36 mm AS sieve to constant mass at a temperature within the range $105\text{--}110^\circ\text{C}$. The material must not be left in the oven for longer than 18 hours. Cool in a desiccator.
- (e) Reduce the dried sample of material passing the 2.36 mm AS sieve, by quartering or riffing, so as to obtain approximately 500 g of the sand-silt fraction.
- (f) Divide the sample by riffing or quartering into portions of approximately 50 g and treat each portion as set out in *Preparation of Samples (g) to (n)* below.
- (g) Place one of the portions in a pyrex beaker marked at 30 mm and 110 mm from the bottom, add about 500 mL of water and boil for 1 hour, stirring briskly every 10 minutes, replenishing water if necessary.
- (h) Add water to raise the level of liquid to the top mark on the beaker and add 10 mL of a 20% ammonia solution.
- (i) Stir with a rubber-tipped glass stirring rod, working sand on the bottom towards the pouring side and finishing with a to and fro motion to avoid rotation on ceasing stirring.
- (j) After stirring, allow the beaker and contents to stand undisturbed for the required settling time, which is determined from the temperature of the water in the beaker, as shown in the following table.

Temperature of Water (°C)	Setting Time (Minutes)
39	5.5
34	6.0
30	6.5
27	7.0
24	7.5
21	8.0
19	8.5
16.5	9.0
14.5	9.5
12.5	10.0
10.5	10.5
9	11.0
7	11.5
6	12.0
4	12.5

- (k) Carefully pour off liquid until the quantity remaining corresponds to the lowest mark on the beaker (30 mm from the base). It is essential that the pouring be so conducted that turbulence is avoided.
- (l) Make up to the top mark on the beaker with water and add 10 mL of 20% ammonia solution. Repeat processes in *Preparation of Samples (i) to (k)* until the liquid poured off is clear.
- (m) After the final pour, stand the beaker at an angle of 45 degrees for about 5 minutes and pour off the balance of the clear water taking care not to remove any of the remaining soil particles.
- (n) Transfer the residue into a clean beaker by carefully washing down all soil particles with small amounts of distilled water using a wash bottle with fine tip.
- (o) Combine the residue from each of the portions to constitute the sample for further testing.
- (p) Agitate gently or stir with a glass rod to remove any entrapped air from the surface of the soil.
- (q) Allow the sample to remain immersed for a period of 24 hours.
- (r) At the end of the period of soaking, drain the water off carefully and expose the material to a gently moving current of warm air, stirring frequently to achieve uniform condition.
- (s) Continue drying until the material approaches the free-flowing condition.
- (t) To assess the saturated surface dry condition place part of the material in the conical mould and tamp lightly using 25 blows of the tamper.
- (u) Lift the mould vertically. If free moisture is present the cone of material will retain its shape.
- (v) Continue drying with constant stirring until the cone of material just slumps on removal of the mould which indicates that the saturated surface dry condition has been reached.

Note: If the cone of material slumps at the first test, it is possible that the material has been dried past the saturated surface dry condition. In this case add a few millilitres of water and mix thoroughly and allow the aggregate to stand in a covered container for 30 minutes. Resume the process of drying and testing until the saturated surface dry condition is achieved.

5. Procedure

Note: Mass to be determined to the nearest 0.1 g.

- (a) Fill a clean conical flask to the mark with distilled water at $25 \pm 1^\circ\text{C}$ and determine the mass of flask and water (Mass D).
- (b) Remove the water from flask.
- (c) Immediately the saturated surface dry condition is reached, place a test portion of approximately 400 g on to a weighing dish and determine the weight of the saturated material (Mass B).
- (d) Dry the material to constant weight and determine (Mass A).
- (e) Place the sample in the volumetric flask through a funnel, taking care not to lose any material during transfer by carefully washing down all soil particles with small amounts of distilled water using a wash bottle with a fine tip.
- (f) Fill the flask to near the mark with distilled water. Roll and shake the flask to eliminate all air bubbles and remove all froth.
- (g) Bring the temperature of the contents of the flask to $25 \pm 1^\circ\text{C}$ by standing in the water bath. Adjust the level of water exactly to the 500 mL mark. Remove from the bath, dry the outside of the flask and determine the mass of the flask and contents (Mass C).

6. Calculations and Reporting

- (a) Obtain the mass of the water displaced by the fine sand fraction $D - (C - B)$.
- (b) Calculate the volume of the water displaced by the sand-silt fraction in mL by dividing the mass by 0.997.

$$\text{Volume of water displaced} = \frac{D - (C - B)}{0.997} \text{ mL}$$

Report as:-

$$\text{Particle Density} = \frac{A \times 0.997}{D - (C - B)} \text{ g/mL}$$

$$\text{Particle Density (SSD)} = \frac{B \times 0.99}{D - (C - B)} \text{ g/mL}$$

$$\text{Water Absorption per cent} = \frac{B - A}{A} \times 100\%$$

Where

- A = Mass of the oven dried test portion.
 B = Saturated surface dry mass of the test portion.
 C = Mass of the flask, water and fine sand.
 D = Mass of the flask and water.

7. Techniques

- (a) It is essential that all of the clay-size particles be removed prior to the determination of the saturated surface dry condition.

If the standard ammonia solution fails to disperse the soil particles other agents may be used. Two of the more common dispersing agents are as follows:

- (i) **Sodium Oxalate.** Add 1 g of sodium oxalate to the soil and water prior to boiling. Use water only to refill beakers after each decantation.
- (ii) **Sodium Hexametaphosphate.** Make a stock solution of 62 g of sodium hexametaphosphate in 1000 mL of water. Add 5 mL of this stock solution to each beaker after each decantation and refill with water. This dispersing agent is effective with many lateritic soils.

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