

Australian Standard[®]

Methods of testing soils for engineering purposes

Method 3.6.1: Soil classification tests— Determination of the particle size distribution of a soil—Standard method of analysis by sieving

1 SCOPE

This Standard sets out the method for the quantitative determination by sieve analysis of the particle size distribution in a soil, down to the 75 µm sieve. By using this Method the combined silt and clay fraction can be obtained by difference. For particle sizes smaller than 75 µm the sedimentation method described in AS 1289.3.6.3, using a hydrometer to secure the necessary data, applies.

NOTE: Particle size limits for defining the various fractions of soils are given in Appendix A.

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)
1289.2.1.4	Method 2.1.4: Soil moisture content tests—Determination of the moisture content of a soil—Microwave-oven drying method (subsidiary method)
1289.2.1.5	Method 2.1.5: Soil moisture content tests—Determination of the moisture content of a soil—Infrared lights method (subsidiary method)
1289.2.1.6	Method 2.1.6: Soil moisture content tests—Determination of the moisture content of a soil—Hotplate drying method
1289.2.3.1	Method 2.3.1: Soil moisture content tests—Establishment of correlation—Subsidiary method and the standard method
1289.3.6.3	Method 3.6.3: Soil classification tests—Determination of the particle size distribution of a soil—Standard method of fine analysis using a hydrometer

3 APPARATUS

The following apparatus is required:

- (a) Balances with limits of performance:
 - (i) for coarse and intermediate fraction±5 g.
 - (ii) for fine fraction±0.5 g.

- (b) Sieves of suitable sizes, complying with AS 1152, to furnish the information required on the soil to be tested, together with a receiver for each set of sieves. Suitable sieve sizes are 75 mm, 37.5 mm, 19 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 µm, 425 µm, 300 µm, 150 µm and 75 µm. Other sieve sizes may be included.
- (c) An oven complying with AS 1289.0 thermostatically controlled to operate at 105°C to 110°C.

NOTE: *Constant mass* Material may be dried to constant mass using other methods such as microwave ovens, infra-red lights or hot plates provided tests have shown that these techniques do not disrupt or weaken particles to the extent that the property being measured changes. The determination of constant mass should be such that after further periods of drying, using the selected method, the loss in mass does not exceed 1% of the total loss of moisture.

- (d) Sample dividers (riffle boxes) of appropriate size openings, similar to that shown in AS 1289.1.1.
- (e) Dishes and trays.
- (f) Sieve brushes and a wire or other stiff bristle brush.
- (g) A reinforced 75 µm washing sieve complying with AS 1152 (optional).
NOTE: *Protection of sieve cloth* Because of the ease with which a 75 µm sieve can be damaged, the use of a special washing sieve, in which the sieve cloth is reinforced underneath with a coarser sieve or punched plate screen, is recommended. Other wash sieves may be used, provided they have a woven wire mesh of 63 µm aperture or finer.
- (h) Mechanical sieve shakers (optional).
- (i) Mechanical dispersion apparatus (optional).

4 REAGENTS

The reagent used shall be sodium hexametaphosphate dispersing solution prepared by dissolving either 33 g of sodium hexametaphosphate with 7 g of anhydrous sodium carbonate (Na_2CO_3) or, alternatively, 18.9 g of hydrated sodium carbonate ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$) in distilled water to make 1000 mL of solution. This stock solution shall be diluted to one-tenth strength for use as washing solution.

5 PROCEDURES

5.1 General

The soil sample shall be separated into a number of sizes, using such sieves as are necessary to furnish the information required. For convenience, the sieving process is normally performed in three stages—coarse, intermediate and fine. It is common practice to use the 19 mm and 2.36 mm sieves to separate the coarse and intermediate sieve analyses and the intermediate and fine sieve analyses, respectively, however, depending upon the analysis requirements and the proportions of the various particle sizes present, other sieve sizes may be more appropriate. In such cases the procedure below shall be followed and the size of the separating sieves shall be substituted for the 19 mm or 2.36 mm size. The number of sieving operations required depends on the maximum size of particle in the sample and the information required.

NOTE: *Allowance for subdivisions* In the calculations care must be taken to make allowance for subdivisions other than those mentioned. With some samples, more than two subdivisions may be required.

5.2 Load on sieves

Overloading of sieves will damage them and affect the accuracy of the results. At the completion of sieving, the maximum load shall be as set out in Table 1. If any sieve becomes overloaded, sieve the sample in two or more portions.

TABLE 1
MAXIMUM MASS OF MATERIAL TO BE RETAINED ON EACH SIEVE
AT THE COMPLETION OF SIEVING

Aperture size	200 mm dia. g	300 mm dia. g	450 mm dia. g
200 mm	—	3750	7500
75.0 mm	—	3000	6000
63.0 mm	—	2750	5500
37.5 mm	1000	2200	5000
26.5 mm	800	1800	4000
19.0 mm	600	1200	3000
13.2 mm	400	900	2000
9.50 mm	250	600	1500
6.70 mm	230	500	1200
4.75 mm	200	400	1000
2.36 mm	150	300	600
1.18 mm	100	200	500
600 µm	75	150	300
425 µm	60	120	250
300 µm	50	100	200
212 µm	45	90	180
150 µm	40	80	160
75 µm	25	50	100

5.3 Methods of sieve shaking

The sieving may be done by hand or with a mechanical shaker. Material retained on the 19 mm or larger sieves may be manipulated by hand.

When sieving by hand, keep the sample moving continuously over the surface of the sieve by use of a lateral and vertical motion accompanied by a jarring action. Continue sieving until the mass passing the sieve in 1 min is less than 1% of the mass of material retained on the sieve. In the case of mechanical sieving, determine the minimum sieving time by comparison with hand sieving. Generally about 15 min sieving is required. Remove particles caught in the sieve openings and add to material retained on the sieve. In the case of the larger sieves, particles can be removed by twisting and turning. For smaller sieves use a sieve brush.

5.4 Coarse sieving

The following procedure shall be used for samples containing particles larger than 19 mm sieve size:

- (a) If the sample, prepared in accordance with the procedure set out in AS 1289.1.1 for the preparation of disturbed samples for testing, contains particles larger than 19 mm size, sieve it on the 19 mm sieve and collect all material passing the sieve. Thoroughly clean all particles retained on the sieve with a wire or stiff bristle brush.
- (b) Sieve the material retained on the 19 mm sieve through the appropriate larger sieves, in order of decreasing openings down to and including the 19 mm sieve, then—
 - (i) record the mass of material retained on each sieve and their sum (m_1); and

NOTES:

- 1 *Soils with clay fraction* Certain soils (e.g. laterites) have large amounts of clay fraction in the interstices of the larger particles. These soils should be treated as described in this method but the large particles retained on the 19 mm sieve should then be washed in the dispersing solution; the amount of clay removed should be determined and allowed for in the final calculations.

- 2 *Nesting of sieves* If the assembly is not too heavy, several sieves, in order of size, may be fitted together and used at the same time.
 - 3 *Checking calculations* At the end of each sieving process, many potential errors can be avoided by checking that the sum of masses retained on each sieve and in the pan equals the original mass of sample within 1 percent.
 - 4 *Zero moisture assumption for coarse particles* It is assumed that the material retained on the 19 mm sieve does not contain any moisture after initial preparation. This assumption is sufficiently correct for all except the more porous types of particles. If the particles are porous, and it is obvious that the material contains moisture, oven-dry the material retained on the 19 mm sieve before sieving and determining its mass. An alternative method is to oven-dry the whole sample.
- (ii) add any material passing the 19 mm sieve in this operation to that obtained in Step (a).
- (c) Determine the mass of all material passing the 19 mm sieve (m_2), then—
- (i) mix this material thoroughly and obtain a subsample of sufficient mass for the particle size, as specified in AS 1289.1.1, by riffing or quartering;
 - (ii) determine the mass (m_3) of this subsample; and
 - (iii) either dry material to constant mass or determine the moisture content (w) of a separate representative subsample of the material in accordance with AS 1289.2.1.1, so that the oven-dry mass of the test subsample (m_4) may be obtained by calculation.

NOTE: *Oven-drying of test subsamples* Mass m_4 may be determined by direct oven-drying of the test subsample, however, this can be time-consuming when large quantities of materials are to be dried. Moisture content of the separate sample may be determined in accordance with AS 1289.2.1.4, AS 1289.2.1.5 or AS 1289.2.1.6, provided a suitable correlation of the method has been made in accordance with AS 1289.2.3.1.

5.5 Intermediate sieving

5.5.1 General

The following procedure shall be used for samples containing particles between 19 mm and 2.36 mm sieve sizes shall be sieved by either the methods specified in Clauses 5.5.2 or Clause 5.5.3.

5.5.2 Washing method

The procedure shall be as follows:

- (a) If the sample, prepared in accordance with the procedure prescribed in AS 1289.1.1 for the preparation of disturbed samples for testing, does not contain particles greater than 19 mm, determine its mass (m_3) and the moisture content (w) of a separate representative subsample in accordance with AS 1289.2.1.1 so that the dry mass of the test sample (m_4) can be obtained by calculation.
- (b) Spread the material passing the 19 mm sieve (m_3) in a large tray or dish, cover with dispersing solution and stir well to wet the sample thoroughly. (With clean granular soils wet sieving may be carried out without the addition of dispersing solution.) Then—
 - (i) allow the soil to soak for at least 1 h;
 - (ii) agitate the sample vigorously and wash the sample with water on the 75 μm sieve suitably protected by a larger sieve, if as necessary, allowing the water containing the silt and clay to run to waste;