

# Australian Standard®

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## Methods of testing soils for engineering purposes

### Method 4.2.1: Soil chemical tests— Determination of the sulfate content of a natural soil and the sulfate content of the groundwater—Normal method

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**1 SCOPE** This Standard covers the determination of the water-soluble sulfate content of natural soil and the sulfate content of the groundwater. The results obtained give the sulfate contents at the time of sampling only and both these values are subject to seasonal fluctuations. The two sulfate contents and the moisture content of the soil are mutually interdependent.

Good practice in chemical testing requires that duplicate specimens should be tested. In this method, the measurement of only one value is described.

**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 Method 1: Preparation of disturbed soil samples for testing

**3 APPARATUS** The following apparatus is required:

- (a) A drying oven complying with AS 1289.0, and which shall be capable of maintaining a temperature of 75°C to 80°C.
- (b) A balance of at least 100 g capacity with a limit of performance not greater than  $\pm 0.005$  g.
- (c) A glass bottle for mass determinations, approximately 25 mm diameter and 50 mm high, fitted with a ground-glass stopper.
- (d) A mechanical shaker or stirrer capable of keeping 10 g of soil continuously suspended in 150 mL of water.
- (e) An extraction bottle of approximately 500 mL capacity.
- (f) A Buchner funnel of about 100 mm diameter.
- (g) A filter flask to take the Buchner funnel, of approximately 500 mL capacity.
- (h) A glass filter funnel of about 100 mm diameter.

- (i) A porcelain or silica crucible 35 mm diameter and 40 mm high or, preferably, a porous porcelain filter-and-ignition crucible 35 mm diameter and 40 mm high with a suitable Gooch funnel and rubber cone.
- (j) A suitable means of igniting the precipitate, preferably an electric muffle furnace.
- (k) Two beakers of 500 mL capacity and cover glasses to fit.
- (l) A desiccator (a convenient size is 200 mm to 250 mm diameter) containing anhydrous silica gel.
- (m) Filter papers to fit the funnels (Whatman Nos 44 and 50 or other papers of similar grading).
- (n) Sieve, 9.5 mm complying with AS 1152.
- (o) Sieves, with receivers complying with AS 1152 as follows:
  - (i) Fine-grained soils . . . . . 425  $\mu\text{m}$
  - (ii) Medium-grained soils . . . . . 6.3 mm and 425  $\mu\text{m}$
  - (iii) Coarse-grained soils . . . . . 12.5 mm and 425  $\mu\text{m}$
- (p) Sample dividers of the multiple-slot type (riffle boxes) similar to those shown in AS 1289.1, having the following widths of opening:
  - (i) Fine-grained soils . . . . . 7 mm
  - (ii) Medium-grained soils . . . . . 7 mm, 13 mm and 25 mm
  - (iii) Coarse-grained soils . . . . . 7 mm, 13 mm and 45 mm
- (q) A suitable mechanical or hand-operated pulverizer.
- (r) A means of obtaining a vacuum, e.g. a vacuum pump.
- (s) A 50 mL and a 25 mL pipette.
- (t) Two glass rods, about 150 mm to 200 mm long and 3 mm to 5 mm diameter.
- (u) A wash-bottle, preferably plastic, containing distilled water.

**4 REAGENTS** The following reagents of analytical reagent grade (AR) are required:

- (a) *Barium chloride 5 percent solution* 50 g of barium chloride dissolved in 1 L of distilled water.
- (b) *Hydrochloric acid, concentrated* Density at 20°C, 1.18 g/mL.
- (c) *Sulfuric acid, concentrated* Density at 20°C, 1.84 g/mL.
- (d) *Litmus paper (blue) or indicator paper* To measure in the range of pH 6.0 to pH 8.0.
- (e) *Silver nitrate 5 percent solution* 0.5 g of silver nitrate dissolved in 10 mL of distilled water. The solution shall be freshly made and stored to protect it from light as it is relatively unstable.

**5 PROCEDURE**

**5.1 Preparation of soil sample for analysis** The procedure shall be as follows:

- (a) Dry the bulk sample prepared in accordance with the procedure prescribed in AS 1289.1 for the preparation of disturbed samples for testing, in the oven at a temperature not exceeding 80°C (see Note 1), and then cool.
- (b) Determine and record the mass ( $m_1$ ) of the sample.

- (c) Sieve the sample on the 9.5 mm sieve, and crush all aggregations, other than discrete particles, to enable them to pass through the sieve (see Note 2).
- (d) Reject the material retained on the 9.5 mm sieve and record the mass ( $m_2$ ) of material passing the sieve.
- (e) Through these and all subsequent operations ensure that there is no loss of fines.
- (f) Divide the material passing the 9.5 mm sieve by successive riffing through the 13 mm divider or by quartering to produce a sample of approximately 100 g. Throughout this and any subsequent operation, thoroughly mix the material available for any division and take precautions to avoid segregation during riffing.
- (g) Pulverize this sample, so that it passes the 425  $\mu\text{m}$  sieve, and then subdivide the sample by riffing through the 7 mm divider until a test portion of approximately 10 g is obtained.
- (h) Place the test portion in the glass bottle and dry to constant mass at a temperature not less than 75°C and not more than 80°C.

NOTE: Constant mass is considered to occur when the differences between successive mass determinations at intervals of 4 h do not exceed 0.1 percent of the original mass of the sample.

**5.2 Preparation of the water extract** The procedure shall be as follows:

- (a) Remove from the oven the bottle containing the dried soil, cool in the desiccator and determine its mass ( $m_4$ ).
- (b) Transfer a test portion of about 10 g (see Note 3) to the extraction bottle, redetermine the mass of the bottle and contents ( $m_5$ ) and calculate the mass ( $m_3$ ) of soil removed by difference ( $m_4 - m_5$ ).
- (c) Add approximately 150 mL of distilled water to the extraction bottle and make the suspension just acid to litmus or indicator paper, by adding hydrochloric acid (see Note 4).
- (d) Place the bottle and contents in the shaker and agitate for 30 min.
- (e) Filter the soil suspension through a suitable filter paper on the Buchner funnel using suction (see Note 5). Wash the extraction bottle and soil, transferring the washings to the filter funnel.
- (f) Transfer the extract to a 500 mL beaker, rinse the filter flask with distilled water, and add to the beaker to make a total volume of approximately 250 mL.

**5.3 Preparation of the groundwater sample** The procedure shall be as follows:

- (a) Collect at least 500 mL of groundwater (see Note 6) in a clean bottle and filter through a suitable filter paper (Whatman No. 44 or similar).
- (b) With a pipette remove 50 mL of the filtrate and place in a 500 mL beaker.
- (c) Add approximately 100 mL of distilled water and make the solution just acid to litmus, or indicator paper, by adding a few drops of hydrochloric acid (see Note 4).

**5.4 Determination of the sulfate content of the soil-water extract or the groundwater** The procedure shall be as follows:

- (a) Test the extract again with indicator paper and, if necessary, make slightly acid as in Clause 5.2 above.
- (b) Bring extract to boiling point and add 25 mL of 5 percent barium chloride solution, drop by drop, while stirring the solution. Keep the covered solution hot, but not boiling, for at least 1 h.